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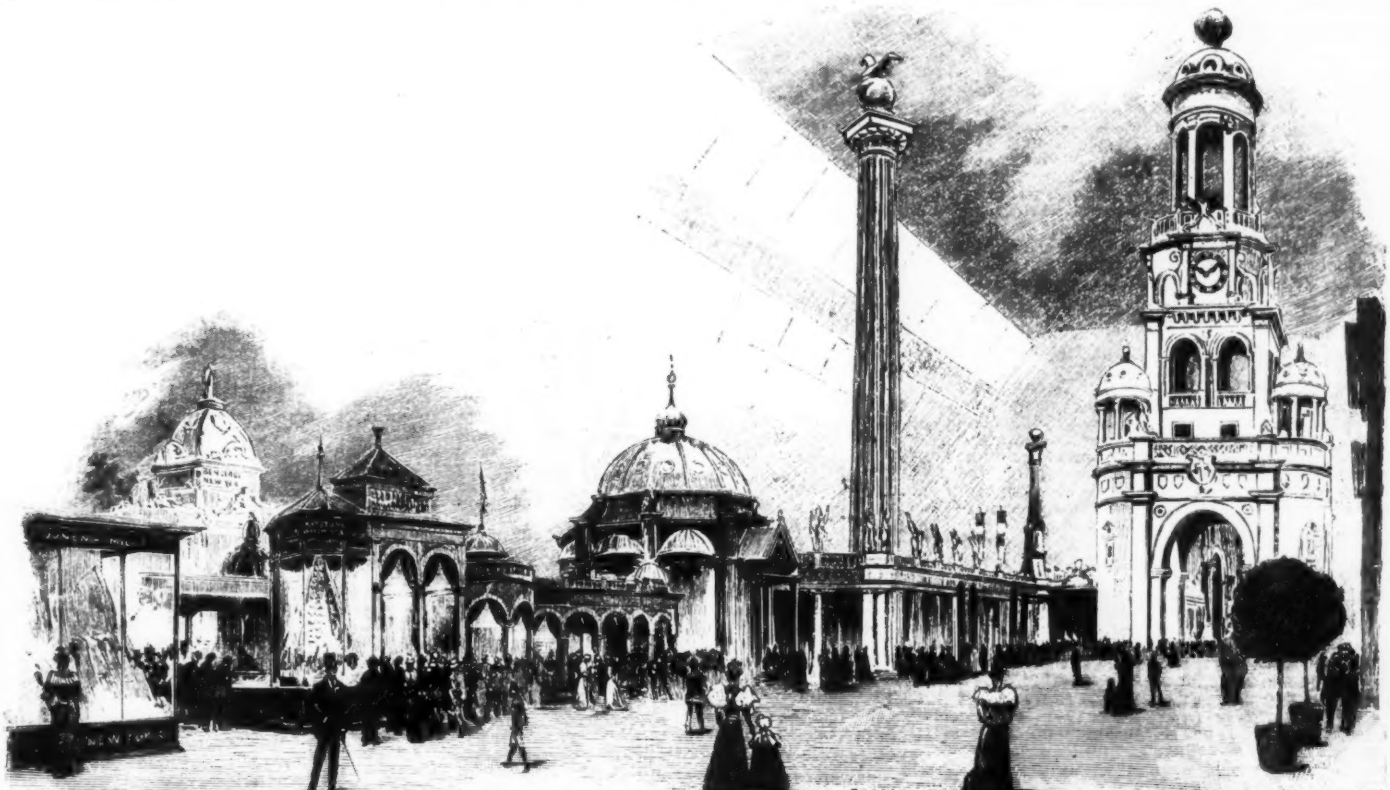


THE WORLD'S COLUMBIAN EXPOSITION—A VIEW IN THE PALACE OF LIBERAL ARTS.—DRAWN BY E. LIMMER.

THE WORLD'S COLUMBIAN EXPOSITION—FRENCH SECTION IN MANUFACTURES AND LIBERAL ARTS BUILDING.—DRAWN BY E. LIMMER.

THE AMERICANS IN THE MANUFACTURES AND LIBERAL ARTS BUILDING.

MORE than a quarter of this immense building is occupied by the United States; their section is three times as large as that of Germany or France, but if the excessive number of objects was reduced to correspond with that of the exhibits of the countries named, that is, if some of the articles had been culled out where there are many of a kind, leaving only as many of each as are exhibited by France and Germany, the American industrial exhibit would be reduced to one quarter of its present size, and the articles offered for inspection, which now cause surprise on account of their number and misconception as to the falsities of execution, would fall behind the work of the European nations, and in many of the branches of industry, especially the artistic departments, would make a very poor showing.

If there are disappointments in store for the European visitor to the Fair at Jackson Park, that caused by the American industrial division is among the greatest of them. Great as has been the development of industries in North America, as shown by the Exposition, and as many branches as are included—there is scarcely one lacking now—the work is remarkable only for its mechanical precision. Everything is done by machine; stamped, pressed, cast, turned, by the dozen, hundred or thousand. This is praiseworthy in its way, but almost everything, furniture, bronzeware, silverware, etc., shows that the work has been done by the dead machine; it has no individual character, one looks in vain for the hand of the workman that should have stamped on it its proper character. The furniture lacks the carving, and the silver and bronze work, the chasing; and the whole lacks the national stamp, the national style.

The American industrial exhibit consists of a systemless collection of articles made by machine. Each exhibitor has built his own pavilion or inclosure, and arranged his exhibit to suit himself; and while the Europeans have erected characteristic facades and arranged behind them elegant reception rooms, one seeks in vain, in the American section, for any such decoration, which would prove an advantage to all the exhibitors, or for that elegance and comfort which are so pleasing and inviting to the visitor and which have contributed not a little to the favorable impression given by the sections of Germany, France, Russia, Austria and Italy.

There the visitor is captivated by the beautiful specimens of artistic work—Gobelins and bronzes, statues, carving, fine porcelain, carpets, laces; but in the American section nothing appeals to the artistic sense, the only things that are fine in the same way as those in the other exhibits are jewels, costly stones, precious metals, clocks, etc. Things that are made by the dozen reign supreme, and what one admires in them is not the artistic, but the practical form, the practical execution. In this respect many things might serve as models from which the European might learn much. The European manufacturer might learn from the American many devices and arrangements, many tricks of manufacture, but the American, on the other hand, can gain very little; for what he learns of European skill he cannot apply on account of high wages, even if he has workmen who have been able to acquire, by instruction, the skill and taste which European workmen find, so to speak, in the air of the workshop, and what has been handed down to them for generations is born in them.

At the entrance of the American section, and occupying the center of the Manufactures and Liberal Arts building, stands a clock tower that is one hundred and thirty feet high (shown in our engraving). At the corners of this structure there are four smaller towers; in the first story are the elegantly equipped reception rooms of the director-general, and in the fourth, the large clock with its melodious chimes.

Germany, France and England exhibit their most beautiful specimens of artistic work at the foot of this richly gilded tower, and on the fourth side America makes a display of precious stones and glittering gold and silver work. The firm of Tiffany & Co., also known in Europe, has built a large pavilion here, and behind the bright glass sparkle the most beautiful precious stones, rubies, emeralds, diamonds, as large as nuts, etc., the value of which amounts to millions. They are certainly mounted in beautiful settings. The designs are most admirable, and the beautiful and costly gold and silver work is finely and elegantly executed; but when one inquires more closely about this New York firm of millionaires he learns that they employ, for the most part, European workmen. So it is only American money that controls, the artistic skill belongs to the Old World.—*Illustrirte Zeitung.*

THE CHICAGO EXPOSITION—THE FRENCH SECTION IN THE MANUFACTURES AND LIBERAL ARTS BUILDING.

ON account of the high rank that France occupies among the civilized nations of the world, she has been assigned one of the four places of honor in the center of the Manufactures and Liberal Arts building, the others having been given to Germany, England, and America. The space set aside for France is as large as that of Germany and England, but it is not nearly as full as theirs; the rooms and passages are larger, wider, more airy, and the whole arrangement more practical, so that the exhibits can be more easily inspected than in the German section, but this is partly due to the fact that France has only one-third as many exhibitors as Germany. Nevertheless, the French section is most admirable, proving afresh the high position which our industrious neighbors occupy in the long line of arts and industries, as well as their assiduity and successful progress in these branches. With their ability and experience in expositions, they are sure of victory, especially in America; for the French rank highest in those industries in which the Americans hold the lowest place, if they possess them at all. They have the necessary money and the desire to possess the French products of this class, and, therefore, the trade between the two countries is remarkably good. The Americans are the best customers of their republican brothers in France, and, keeping this in view, the latter sent many things to the Chicago Exposition. But this time they did not take into account the Germans, who had opened a sharp competition directly opposite their section, and, while coquetting less with the golden mammon, attract a crowd of customers simply by their beautiful exhibits, whose patronage, it is hoped, will be continued after the Exposition.

The facade of the French structure on the main aisle of the building for Manufactures and Liberal Arts is not as characteristic and artistic as that of the German section, but is, nevertheless, very imposing and worthy of the products that it incloses. Passing through an immense portal decorated with flags and festoons, we find ourselves in the Court of Honor of the French section among specimens of the manufactures of that country. A statue of the Republic occupies the center of the room. It is the work of Falguyere, who, it is said, designed and executed it in twenty days. On the walls hang the latest products of the celebrated Gobelin works at Paris and Beauvais, true masterpieces, unsurpassed by any. This time the palm should be given to the piece of Beauvais tapestry called "The Godchild of the Fairies." It took fifteen years to make this piece of tapestry, and the price asked for it is $119,000. Opposite this hangs another beautiful piece made from a design by Ehrmann, an allegorical representation of art and science. On the other walls hang small Gobelins also executed in a masterful manner, but the colors in these are rather crude. Heretofore the Parisian Gobelin works have stood higher than those in Beauvais, but, after seeing the exhibits in Chicago, the justice of this seems doubtful. The great and elegant pieces were formerly made in Paris, while the works in Beauvais made smaller pieces for walls of rooms and more particularly for furniture covering, the charming pictures of Watteau supplying the preferred designs.

Many of these beautiful pieces of work are seen on the furniture, a large display of which is contained in the French section. The French furniture makers have arranged their furniture in rooms, which they have supplied with tapestry, carpets, bronzes, and bric-a-brac, thus showing their goods to the greatest advantage.

There are many specimens of the beautiful porcelain from the Sevres factories, some of which surpass those exhibited at the Paris Exposition. The masterpiece in the extraordinarily rich exhibit of bronzes is an immense vase, more than 16 ft. high, modeled and executed by Dore. The numerous figures—some of which are in high relief and some completely formed—representing a feast of Bacchus, are executed in a most masterful manner. The price asked for the vase, $20,000, is not by any means high. The exhibit of precious stones and gold and silver work is one of the finest in the Exposition, and Parisian dresses, toilet articles of all kinds, silks, ribbons, etc., inclosed in long rows of glass cases, complete this section.—*Illustrirte Zeitung.*

[Continued from SUPPLEMENT, No. 927, page 14814.]

THE WORLD'S COLUMBIAN EXHIBITION: A GENERAL VIEW.

THE Mining building, by S. S. Beman, of Chicago, is situated to the west of the Electricity building, and has its major axis running north and south, the southern facade facing the central court. It occupies an area of 350 ft. by 700 ft., and is principally interesting in that the cantilever system, so generally employed in bridge construction, has been employed here in the construction of the roof to the main nave and aisles. It is the only example of this in the Exhibition, and it is said to be the first application of this ancient principle of construction for the purpose of supporting a roof covering, at any rate on so large a scale. The plan consists of a nave 115 ft. from center to center of steel stanchions, with an aisle 57·6 ft. wide on each side. From the steel stanchions which separate the nave and aisles, the roof of the aisles is cantilevered over in the nave for a distance of 34 ft. 6 in. on each side, the upper part of the lattice work truss being, of course, in tension and secured to the outer chord of the aisle roof, which is secured to the outer standards. The roof slopes down in one continuous line from the upper end of these cantilevered trusses over the side aisles. The space, 46 ft. wide, thus left in the center of the nave is spanned with riveted steel trusses, joined to the ends of the cantilevers and having an elliptical lower chord, the upper part being raised to form a clearstory for lighting purposes. This central nave and aisles are in one height only and around this space are placed galleries in two heights, lighted from windows in the facades, the upper floor being additionally lighted by a raised central clearstory. This outer ring of galleries is supported entirely by columns of wood, and is covered with wooden-framed roof. The entrances are arranged in the center of each facade, those on the north and south being the most important, and these are recessed. On either side of these four entrances are wide staircases leading to the gallery floors. The exterior of the building is, like the other main structures of the Exhibition, composed entirely of "staff," and is treated in a massive way, as it were, to bring out the expressive qualities of mining. The main cornice is 60 ft. high from the ground, as in the other buildings fronting on to the Great Court, and is supported on the main fronts by massive rusticated piers, corresponding with the internal divisions of the plan, and crowned with sculptured heads which act as a base for the flag poles which crown them.

The principal fronts have semicircular arched entrances, with sculptured figures in the spandrels and pediment, emblematic of mining and its allied industries. On either side of this central entrance is arranged a recessed loggia 25 ft. wide in two stories, the upper one corresponding with the gallery floor level from which it is reached. At each end of these fronts, at the point where the surrounding two-storied aisles intersect, low domes are formed and crowned with a small gilded lantern. A decided French spirit pervades the whole of the exterior design, and is manifested in the carving to the main frieze, in the treatment of the piers to the main entrance, with their escutcheons, and in the carving to the spandrels. The ornamentation throughout is scarcely bold enough to harmonize with the massive phase of architecture adopted. There is practically no sculpture properly so called, nor has any scheme of color decoration been employed, as in most of the other large buildings. As for the interior, we have mentioned the somewhat novel employment of the steel cantilever trusses, and the awkward and abrupt line caused by the termination of the cantilever on each side, thus stopping the grand sweeping curve of the truss. This is all the more noticeable because we are accustomed to see the principals in these roofs extend without interruption from one side to the other. It is perhaps only on account of this reason it is displeasing, but it certainly gives a broken line which destroys the homogeneity of the design. All credit is, however, due to Mr. Beman for his employment of a novel feature such as this in his design, and there is certainly a character and feeling about the whole composition which makes it peculiarly suitable to the purpose for which it is designed.

The Transportation building, by Messrs. Adler & Sullivan, of Chicago, is in many respects the most remarkable and interesting on the grounds. The architects are well known as the designers of the Auditorium Theater and Hotel, the Schiller Theater, and other tall buildings in Chicago. The interest, however, in this case, does not come from any new development in construction, as in the buildings referred to, but simply because the building has been designed from the very beginning as a color scheme, pure and simple. As to architectural features, as we understand them, there are none, the facades, with the exception of the great central doorway on the east front, consisting of flat plaster surfaces upon which the painting has been directly applied.

In regard to plan, the uses to which the building had to be put very naturally exercised a considerable influence in its development. In this case the architects had to consider the most convenient handling of heavy engines on rails which were to be placed transversely to the main axis of the building. They found that 16 ft. for each pair of rails allowed sufficient circulation for the public to inspect the exhibits, and by grouping these in pairs, 32 ft. was obtained as a module upon which the plan was laid out. The building itself is 960 ft. by 250 ft. and consists of a main nave 96 ft. wide, around which are placed two-storied aisles. The nave walls are carried high above these aisles and contain clearstory windows, lighting the nave and giving sufficient light for large exhibits, such as balloons and the like, which are illustrative of transportation.

Staircases for access to the galleries are arranged at each end and at the great entrance on the east side facing the lake, while transportation is well exemplified by a series of eight lifts in the center of the building running from the ground to the roof, which is used as a promenade. This series of lifts is marked externally by a turret springing from the ridge. The facade consists of a continuous arcade, with wide piers, inclosing a subordinate colonnade and entablature under each arch, the facade being crowned with a deeply projecting cornice 58 ft. from the ground, which serves to protect the color from the weather. In the center of the east facade is the great semicircular archway, with receding planes elaborately carved, and which is known as the Golden Gateway; it is 100 ft. wide and 70 ft. high, and has a square projecting cornice raised above that to the aisle. On each side of the entrance, in the space caused by the projection of the porch, are placed octagonal kiosks with a projecting balcony under and covered with a circular roof. These balconies are approached by external staircases, and are elaborately treated with sculptured decoration. It was originally intended to cover the whole of the central gateway with gold leaf, but from motives of economy it was treated with aluminum, and covered with a yellow lacquer, the effect of which is very fine, as, by the action of the weather, the tone varies. The parts below the surface are picked out in subdued blues and reds to accentuate the form.

The important color scheme introduced into this building will be treated in a separate article.

The Horticultural building, by Messrs. Jenney & Mundie, of Chicago, is situated immediately to the north of the Transportation building, with its main frontage of 1,000 ft. facing the wooded lagoon. The plan consists of a central dome constructed with lattice ribs of light steel springing from the ground, the dome itself being 180 ft. in diameter and 115 in height, and is placed in the center of a square pavilion. The dome is almost semicircular in form, being struck from the level of the first story, 25 ft. from the ground, and therefore only 25 ft. more than its radius, and 65 ft. less than its diameter, which is a novel proportion for a structure of this kind. It is supported on either side with smaller domes toward the front, and, as it were, filling up the angles of the square base from which the dome springs. The main entrance, placed on the axis of the dome, consists of a projecting porch with semicircular arched opening supported on Ionic columns and with sculpture group on either side. At the extreme ends of the facade on either side are two-storied pavilions 118 ft. on face and 250 ft. deep. These are connected with the central structure by two low one-story galleries 90 ft. apart, thus forming an open court of this width between them for the display of flower gardening, etc. The rear gallery is continuous between the main wings, but the front one stops on either side against the square mass supporting the central dome.

The roof to the front galleries is circular in form, that to the rear being a double pitch one. It was natural that a building devoted to horticulture should take the form of a gigantic greenhouse, and the architects seem to have realized this, and further to have succeeded in giving the building something of a monumental appearance. The central dome, which is of real utility, and even necessary for the proper display of huge palms, tree ferns, bamboos, etc., and which is supported on either side by the two smaller domes, is a very well conceived feature, and being so low in proportion to its height seems to grow, as it were, out of the ground, and to be therefore quite in keeping with the object for which the building is designed.

As to the general scheme of the exterior, it seems to be founded, in its main essentials, more or less on the Library of St. Mark, at Venice. The curtain walls

consist of a series of Ionic pilasters, around which the cornice breaks 22 ft. 6 in. from the ground, the alternate pilasters being carried up and crowned with flag poles. Between the pilasters are semicircular arches allowing the largest possible amount of glass. The two wings are, as has been mentioned, in two stories. On the ground story the Ionic order to the curtain wall is carried round, while the upper story is also treated with the Ionic order, over which is placed an entablature with a frieze 6 ft. in depth, and therefore out of proportion to the height of the columns. This frieze is very richly modeled with figure subjects, garlands, and festoons. It was, however, deepened in this way so as to give height to this portion of the building, and to enable it to compete with the neighboring structures in this respect; but the exaggerated height of the frieze is hardly satisfactory, and it has not the great quality of utility which induced Sansovino to exaggerate his frieze at the St. Mark's Library. Mr. Lorado Taft, of Chicago, is responsible for the decorative modeling and sculpture on the building, some of which is unquestionably very fine. The two groups on either side of the front entrance, placed on a high pedestal, and representing the "Awakening" and the "Sleep" of Flowers, in which the principal figures are 8 ft. high, are treated with poetic feeling and thoroughness of *technique* which make them worthy of more than a temporary existence. The whole structure could not be taken for anything else but a gigantic greenhouse, but it is a greenhouse in which a certain amount of graceful and monumental effect has been gained, and which certainly makes it a success.

To the north of the Manufactures building stands the United States Government building, probably the worst in design and general treatment on the ground. It is, however, interesting in showing us to what depths official architecture has sunk in the States. But good may come of it, seeing that it has apparently sounded the death knell of the system, as a bill is now before Congress which will cause all public buildings to be thrown open to competition. The building is rectangular in plan, and measures 350 ft. by 420 ft. In the center is placed a dome 120 ft. in diameter and 150 ft. in height, constructed of steel and supported on sixteen columns. The space below the dome gives access to all the principal galleries, whose main axes run north and south. The main entrances are on the long facades, while square pavilions with pyramidal shaped roofs occur at each angle. The exterior is in a very coarse type of Renaissance, which is hardly worth criticising, so poor and meaningless is it in design and commonplace in general conception.

The dome rises in the center, and though not absolutely bad in general proportion, the detail is singularly so, and the black coloring of the panels between the ribs does not help it. Probably the worst part is the "ornamentation" to the interior of the dome, in which sprawling cupids, flowers, fruits, and the national trophies are mixed together without any regard to color, treatment, or suitability, and making it altogether one of the most vulgar attempts at decoration it is possible to imagine.

The Fisheries building, reached by a small bridge over the canal to the north, is by Mr. Henry Ives Cobb, of Chicago, and consists of a large central structure with two smaller polygonal buildings covered with pyramidal roofs and connected with it on either side by arcades. The extreme length is 1,100 ft. by 200 ft.

In the center of the main building is a rotunda 60 ft. in diameter. The exterior is interesting in that Mr. Cobb has exerted his ingenuity in arranging innumerable forms of capitals, brackets, etc., in which, while the general form has been kept on Romanesque lines, fishes and sea forms generally have been worked into the designs. "Staff" lends itself very favorably to this intricate form of modeling. The roofs are covered with red Spanish tiling, which contrasts not unfavorably with the toned coloring on the walls.

The Art building, situated still further north and fronting on to the smaller lagoon, is a very chaste piece of modern French work of the most refined and scholarly type. It is by Mr. C. B Atwood, of Chicago, the designer in chief to the Exhibition. In plan it consists of a central building 500 ft. by 300 ft., with a central gallery 70 ft. wide on the center of each axis and in one height. At the point of intersection of these galleries rises a flat dome 60 ft. in diameter, springing from a low pediment on each face above the roof. At the end of each of the naves, where they abut on the facades, are grand entrance porticoes of Ionic columns, and with sculptured friezes with figures and pediments, and approached by broad flights of steps. Along the facades on each side of the entrances are Ionic colonnades forming covered ways, behind which are the walls of the aitch galleries, the inner ones abutting on the central naves; these great naves are occupied with sculpture and statuary as in the last Paris Exhibition, and the inner picture galleries are entered from these naves and lighted from the top. On either side of the main building are one-story annexes 200 ft. by 120 ft., which are connected with the main building by colonnaded galleries, and which project toward the north, thus forming a three-sided court toward the main front; these are treated somewhat similarly to the main building, with colonnaded entrances on two of the faces, and low central stepped dome.

The design, both as a whole and in detail, is one of the most satisfactory on the ground, but it is thoroughly French, and appears to be founded in its main features, especially the principal entrances, on a Prix de Rome design submitted by M. Benard, in 1867. The well known treatment of the frieze figures is here introduced, and many other distinctive similarities are noticeable. The upper parts of the walls behind the smaller colonnades to the wings have reproductions of the Parthenon frieze, harmonizing well with the general Greek feeling pervading the design and with the purpose of the building. Mr. Philip Martiny has executed the other sculpture work on the building, and his figures representing architecture, painting, and sculpture on the main frieze are very finely conceived. The building is fireproof throughout, necessitated, of course, by the costly contents. The *tout ensemble*, as seen across the lake in front, is one of the most satisfactory of modern "classic" designs that we know of.

Immediately to the north of the Horticultural building is the Woman's building, erected from the designs of a lady architect, Miss Sophia Hayden, of Boston, and a graduate of the Massachusetts Institute of Technology at that place. It is Renaissance in design. In plan, the main feature is the great hall, 250 ft. long and 67 ft. wide, in one height with elliptical roof and lantern light. This central hall is surrounded by a two-story structure, consisting of committee rooms, lecture rooms, etc. Staircases are placed at each angle of the building. On the inner part of the flat roof is placed the restaurant, while the outer portion is used as a roof garden.

The elevation consists of a ground story of Ionic pilasters formed into columns, where the colonnade occurs, and an upper story of Corinthian pilasters and entablature, above which is a screen of small columns, standing above the parapet, and with caryatids interspersed, thus forming a screen for the training of creepers, as in some of the Genoese palaces. We have previously stated our opinion about this building. It appears to have been studied in an atelier, and to be a school problem. The plan is very badly laid out. The rooms surrounding the hall are dark, and the general scheme seems imperfectly studied, in marked contrast to the other buildings, while the exterior seems a meaningless array of columns and pilasters, with very little reference to proportion or composition.—*The Builder.*

[FOR THE SCIENTIFIC AMERICAN.]

DEVELOPMENT OF MINERALOGY.

By L. P. GRATACAP.

IT may well be imagined that at a very early period in the history of man the beauty of crystals and the range of colors in minerals must have attracted attention. So easily aroused are the senses by any strong appeal of external nature that the brilliancy of quartz, the flash of pyrite, the dominant tints of agate, and the greens, reds, purples, and yellows of rocks could not long have remained unobserved. Industrial needs and the "house instinct," with its later architectural developments, soon led men to explore the mineral resources of the land, and to start in motion those useful and artistic studies that created metallurgy and sculpture. But, long before the quarries of Paris and Syene had been started, or the zinc beds of Leamium and the iron ore of Elba explored, the rude prehistoric races of all lands had consecrated to especial favor some sorts of stones, and added the extreme exertions of their trained labor to increase their beauty. The polished and exquisitely shaped celt was made from those green stones which seemed very early to attain distinction with primitive people, and this color in jade, jadeite, saussurite, chloromelanite, and gabbros, so extensively prevails in the ornamented or highly finished implements of the lake dwellers, the steatitic ollas of Californians and the New Zealand axes, as to lead many students to ascribe it to a peculiar constitutional tendency of taste among them. Prof. James Terry has said, "The 'color of spring,' which has been applied to jadeite and nephrite stone, seemingly has some inherent virtue in the eyes of barbaric and semi-civilized races."

Very early, also, differentiation in the nature, uses and properties of *stones* was made, and later the peculiarities of *minerals* afforded pleasure or suggested value to these archaic populations. In the mounds of the Mississippi Valley Squier and Davis found sheets of silvery mica, blocks of glistening galenite, and lumps of hematite. Prof. Terry, in his exhaustive explorations in American archæology, has found in the Indian graves of southern California quartz crystals, single terminated pellucid individuals, cut and polished amethystine beads, and sinkers of magnetite, while the elegant and delicately chipped arrowheads of Oregon have been formed from the agate and chalcedony pebbles of the river beaches. But it is much later, in the ages succeeding these earliest days of aboriginal culture, that mineral distinctions were clearly made, names applied to mineral species, and an exchangeable value put upon the inorganic products of the earth.

In China, India, Persia, Palestine, Egypt, Greece, Carthage, and Rome we find an increasing knowledge, accompanied, in the case of Greece and Rome, with a fragmentary attempt at system. The gem stones, the ores, and industrial salts, naturally were first distinguished, and in China, from an immemorial antiquity, the jadeite or *Yu* stone possessed an almost sacred importance. The jadeite of China was elevated by their writers into an emblem of constancy and virtue; it constituted the most valued possessions of their mandarins, and three thousand years before our era received the affectionate workmanship of their skilled artisans. Sanskrit writers have recorded the knowledge of the diamond among the natives of India in very early times. The ruby and sapphire of Ceylon have entered into the decorations of native princes, and served for the embellishment of idols in Hindoo temples. The corundum mines of Upper Burma, where the ruby occurs in limestone, also in gem-bearing gravels, have been worked for centuries.

Among the ancient Jews precious stones appertained to their most sacred offices. We read in the St. James version the remarkable description of the breast plate of judgment (Exodus, chap. xxviii., verses 17-20), "And thou shalt set in it settings of stones, even four rows of stones; the first row shall be a sardius, a topaz, and a carbuncle: this shall be the first row.

"And the second row shall be an emerald, a sapphire, and a diamond.

"And the third row a ligure, an agate, and an amethyst.

"And the fourth row a beryl, and an onyx, and a jasper; they shall be set in gold in their inclosings."

The rings of the Egyptians were mostly of gold and silver, but frequently their armlets and bracelets were inlaid with precious stones (see Exodus xxxv), and among these were lapis-lazuli, red and green stones of undetermined natures.

Wilkinson ("Ancient Egyptians") says: "The scarabæus itself was of green stone, carnelian, hematite, granite, serpentine, agate, lapis-lazuli, root of emerald, amethyst, etc." The arts of Chaldea seem to have scarcely employed mineral accessories, and Rawlinson says there is found in their art relics no silver, zinc, or platinum; only gold, copper, tin, lead, and iron. Assyria seemed also to have used stones in its arts infrequently. Of Babylonia Rawlinson ("Ancient Empires") contains the following instructive and suggestive paragraph:

"It may be doubted whether any gems were really found in Babylonia itself, which, being purely alluvial, possesses no stone of any kind. Most likely the sorts known as Babylonian came from the neighboring Susiana, whose unexplored mountains may possess many rich treasures. According to Dionysius, the bed of the Choaspes produced numerous agates, and it may well be that from the same quarter came that 'beryl, more precious than gold,' and those 'highly reputed sards' which Babylon seems to have exported to other countries. The western provinces may, however, very probably have furnished the gems which are ascribed to them as amethysts, which are said to have been found in the neighborhood of Petra, alabaster, which came from near Damascus, and the *cyanus*, a kind of lapis-lazuli, which was a production of Phenicia. No doubt the Babylonian love of gems caused the provinces to be carefully searched for stones, and it is not improbable that they yielded, besides the varieties named and the other unknown kinds mentioned by Pliny, many, if not most, of the materials which we find to have been used for seals by the ancient people. These are carnelian, rock crystal, chalcedony, onyx, jasper, quartz, serpentine, syenite, hematite, green feldspar, pyrites, lodestone, and Amazon stone."

In the industrial needs of early civilizations the efforts to extract from the earth its useful metals brought men in contact with the mineral associations of metalliferous beds and veins, and in this way probably the more extended acquaintance with the stony contents of the earth's surface arose. The turquois, however, in Persia, exerted a strong attraction for the inhabitants and was probably mined for its intrinsic beauty, from a narrow vein in a trachitic rock. Among the Aztecs Prof. Blake believes that the turquois possessed a pre-eminent value, and he refers the famous designation "chalchuith" to this mineral. From such casual reminders we are led to surmise that a moderate acquaintance with the more prominent minerals of the earth was acquired long before the subject was approached in a systematic manner by writers. This knowledge became disseminated through commerce among nations and the Phenician sailor became a substantial factor in bringing about the first attempt at classification, by not only adding to the information acquired, but by giving it a wider acceptation.

The vigilant Phenician navigators in the active search for metallic wealth established trading stations along the shores of the Mediterranean Sea; they also visited the silver mines of Spain, the lead mines of Brittany and the tin veins of Cornwall and presumably the amber beds of the Baltic. Their artisans in Tyre and Sidon excelled in workmanship and they furnished to King Solomon the assistance he needed in the preparation of the temple. But perhaps no attempt, which assumed the character of a scientific examination, was made to classify and enumerate minerals until the time of Aristotle and his pupil Theophrastus, in the fourth century before Christ. The extent of their work is very partially known, but may have been in part reincorporated in the works of the physician Dioscorides. Among the remains of classical antiquity the works of Pliny the Second are the most exhaustive and pretentious in their treatment of natural history. In the famous books which have come down to us we have a rambling dissertation on all subjects of human knowledge, as then developed, in which the aspect, inhabitants, and products of the earth are involved. In the thirty-sixth and thirty-seventh books, stones and gems are taken up and their discussion is richly garnished with tales, fables, and historic incidents. It is impossible to discern anything but the most superficial method in their arrangement, and of course little or nothing more could be expected.

The processes of chemistry, the laws of crystallography, and the optical properties of minerals were then unknown, unsuspected, and the classification depended upon what was extracted in metal form from natural earths, or minerals, what industrial or medicinal uses they subserved, and their color, hardness, texture etc.; in short, their natural appearance and behavior. These three points of reference outlined the classification of minerals so far as the ancients possessed any classification at all, and it, of necessity, led to confusion and error. A few references, freely translated, from these notable essays of Pliny are of interest, and serve to emphasize the partially childlike condition of natural science in his time and the peculiar mixture of conceptions derived from organic with the facts of inorganic nature. This condition of science prevailed long after Pliny, and assumed a semi-metaphysical character in the middle ages, and was not entirely eliminated even in the days of Linnæus.

After a long chapter on marbles, their uses, varieties, and the celebrated structures or beautiful statues made from them, with incidental expressions of alarm and regret that luxury among the Romans had reached so great a height, our author continues: "Leaving marbles for the marvelous characters of other stones, who would hesitate to place the magnet in the first place? What more wonderful or where a greater perversity in nature? She has given a voice to stones, as we may say, answering man, truly speaking back to him. What harsher than the rigidity of stone? Lo! she has given to it sense and hands. What more unyielding than the hardness of iron? But it yields and undergoes discipline. For it is drawn by the magnetic stone, for that material, dominator of all things, runs to the viewless power, I know not what: and as it comes nearer, it is lifted, is held, and adheres by an embrace. On account of this they call the *siderite* by another name, the Heracleon* stone. Discovered in Ida, it is called by its author *Magnes*. It is found everywhere, as for instance in Spain. It is said to have been found adhering to the nails of the shoes, and the spike of the shepherd's crook, when he pastures the herds. Sotacus showed that there were five kinds of magnet. . . . The first difference was in their male and female principles, the second in their color. For what is found in Macedonia is red and black, but the Bœotian truly has more red than

* Heracleon had the significance of adhering.

black color. That which is found in the Troad is black and of the feminine sex, and therefore lacking in strength. The poorest is in Asia, shining, and not drawing iron, and like unto pumice. The best are more blue. The Ethiopian variety is most praised, and is exchanged for silver. There is also found hematite, a *magnes* of a red color, which rubbed gives off a bloody tint, and also a saffron. In attracting iron there is not the same nature in hematite as in *magnes*. All these are good medicines for the eyes, each in its proper measure, and especially they stop a running of the eyes. Burnt and crushed they cure burns. Again there is another mountain in this same Ethiopia, not far off, which produces the *theamiden* stone, which repels and drives away iron."

Pliny speaks frequently of the medicinal properties of minerals; and the ochers and iron stones, with so-called schist, seem to have served very curious medical uses.

Hemorrhoids, burns, weakness of the eyes, liver troubles, blood diseases, were treated with preparations of these natural earths, some of which may have been in part vegetable in their origin and nature. The eagle stones, familiar to collectors as limonitic concretions holding pebbles and commonly inclosing a quantity of white sand inside of a ferruginous rind or crust, are alluded to by Pliny. The passage occurs in the thirty-ninth chapter of his thirty-sixth book. He says they are found in the nests of eagles, and that it is reported that there are always two, male and female, but that of these stones there are four kinds. Those from Africa are small, soft, friable, holding within them white smooth clay. These he considers feminine in sex. Whereas the male sorts are hard, reddish, and inclose a hard pebble and are found in Arabia.

The third came from Cyprus and are spherical, inclosing sand and stones. The fourth, called Taphian, came from the mountain Taphyus, and were there taken from streams, shining and round in appearance. Parturition was prevented by these stones. A glance at Pliny's treatise on gems is of interest, and in connection with the foregoing gives some impression of the crude, inchoate, and purely artificial condition of mineralogical science in his day.

THE ART OF MINING BY FIRE.

By Mr. Arthur L. Collins.

In olden times, before the invention or common use of explosives, the best method available for mining through the hardest kind of rock, such as resisted the use of hammer and wedge, was by means of fire. Nothing is more natural than that the effect of fire on rocks should have been known at a very early period; no one who has lighted a fire on rock can help noticing the rending effect of the heat. The same thing would be seen after any natural forest fire; several examples on a very extensive scale have recently come under the writer's notice in Australia, where bush fires of great extent are frequent, and all the rock cropping out at surface is seen to be cracked and split over great areas. The great trouble with the fire setting seems always to have been the heat and smoke produced—the latter being often strongly sulphurous, where the ore contained pyrites or other sulphides. It is easy to see that this would have been a great obstacle, where the means of artificial ventilation were so imperfectly understood; but it implies far less at the present day. Indeed, by a proper system of ventilation with upcast and downcast shafts, it need be no more objectionable than the ventilating furnaces still used in some collieries; and at Kongsberg silver mine in Norway, the system is still used occasionally for driving levels, mainly on account of the great improvement in ventilation which it causes throughout the mine.

The writer has recently had an opportunity of seeing the process at work in this mine, and as it is perhaps the only place of importance in Europe where it still survives, a few details of the mode of working may be of interest. The process is now confined to the occasional driving of levels in hard siliceous gneiss—it having been found that the micaschist and and other micaceous rocks which also occur at Kongsberg are far less favorable for fire setting. A short piece of level is driven at first in the ordinary manner, to get room to start the process; and wood—mainly logs of white fir and red pine, dry and split—is closely piled up so that the fire plays against the "face;" waste wood or old timbers from the mine being often piled against the freer burning fir, to concentrate the heat. When the pile is lit smoke fills the level, and the men leave it, but in two or three hours it is generally burnt out, and as soon as the men can come in the broken stone which is split off is cleared away, and all that is sufficiently loose is broken down. The fire sets stronger on the roof and sides than on the sole, so that the levels have a constant tendency to slope upward. This can partly be prevented by better arrangement of the fuel, putting long pieces at the bottom and covering the upper part; but sometimes the sole has to be blasted. The ordinary speed of driving is from five feet to twenty feet per month. Prof. Helland states that fire setting kept its place as the common method at Kongsberg so long as double-handed boring, iron borers and powder were used; but that on the introduction of single-handed boring, steel borers and dynamite or other high explosives, the use of the old method rapidly died out.

In 1864 fire setting was both cheaper and quicker than the old method of blasting with powder in large holes; but on the introduction of dynamite and small holes, things were entirely reversed; not only did the new method effect a great saving in time and cost, but fire setting became actually dearer than before, owing to the increasing wages. It should be added that at Kongsberg suitable wood is very cheap—an important point, when it is remembered that about nine parts (by volume) of wood are required to one part of rock, and that much less skilled labor is employed for the fire setting, as is indeed shown by the rate of wages paid. There seems to be little reason to believe that fire setting is very unhealthy for the men employed, when care is taken to insure efficient ventilation. No doubt the great heat developed is prejudicial; but perhaps not more so than the dynamite smoke, the constant jar to system in heating the drill, and the fine, sharp dust often inhaled, incidental to the more modern process.

Attempts have been made at various times to improve the fire setting methods, by using turf at the Rammelsberg mines in the Harz, and brown coal in the tin stock works at Altenberg; but neither was successful. Better results were obtained with coke at the St. Christoph mine, near Breitenbrunn in Saxony. At Felsobanya, in Hungary, the method is improved by the firewood being held in an iron framework on legs or wheels ("pregelkatze"), which concentrates the fire and improves the draught. According to Serlo, Hugon has used a small furnace, mounted on wheels, supplied with a blast to urge the flame direct on to the rock, at the Challenges mine, in France. Burning small coals, this apparatus in fifty-five hours drove an end four feet wide and six feet high a distance of five feet; while two men with the usual explosives would only drive the same end from five to six and a half feet in a month. If this were done at a reasonable cost, it would be a very fine result, but as to relative economy Serlo gives no particulars.

As to the possible future of the fire setting method, it is unlikely that it will ever again come into use to any important extent; for although it could hold its own under suitable conditions against blasting with powder, yet the modern improvement in high explosives and boring machinery, which have deprived mining through the hardest rock of all its terrors, have done away with any necessity for the old process. Yet, in exceptional cases, where machinery and skilled labor are not available, fuel cheap, and the rock very hard and siliceous—conditions which occasionally confront the mining engineer in semi-civilized countries—it would be worth while to reconsider its many advantages.—*Am. Gas Lt. Jour.*

APPARATUS FOR ASCERTAINING THE EFFICIENCY OF SCREW PROPELLERS.

The direct benefits that have resulted from experimental investigations at the Admiralty Experimental Works, Gosport, and which include, among other things, a general advancement of speed in our warships, have imbued other nations with the desire to be able to ascertain the probable speed of particular forms of ships from experiments with small scale models. Some three years ago the Italian naval authorities erected an experimental tank at Spezia, and the Russian Admiralty are at present busily engaged with the construction and equipment of similar works at St. Petersburg; while the progressive spirit of American naval designers has already turned itself in this direction, and there is every possibility of a tank being established in the United States in the near future. Both the Russian and Italian establishments are similar to the works at Haslar, the arrangement of which and the design of many of the appliances forming its equipment are due to the genius of Mr. R. E. Froude, son of the late Dr. William Froude, the originator of the experimental system of investigation with ships' models.

The special apparatus for determining the relation of speed to power of ships from their models, and the

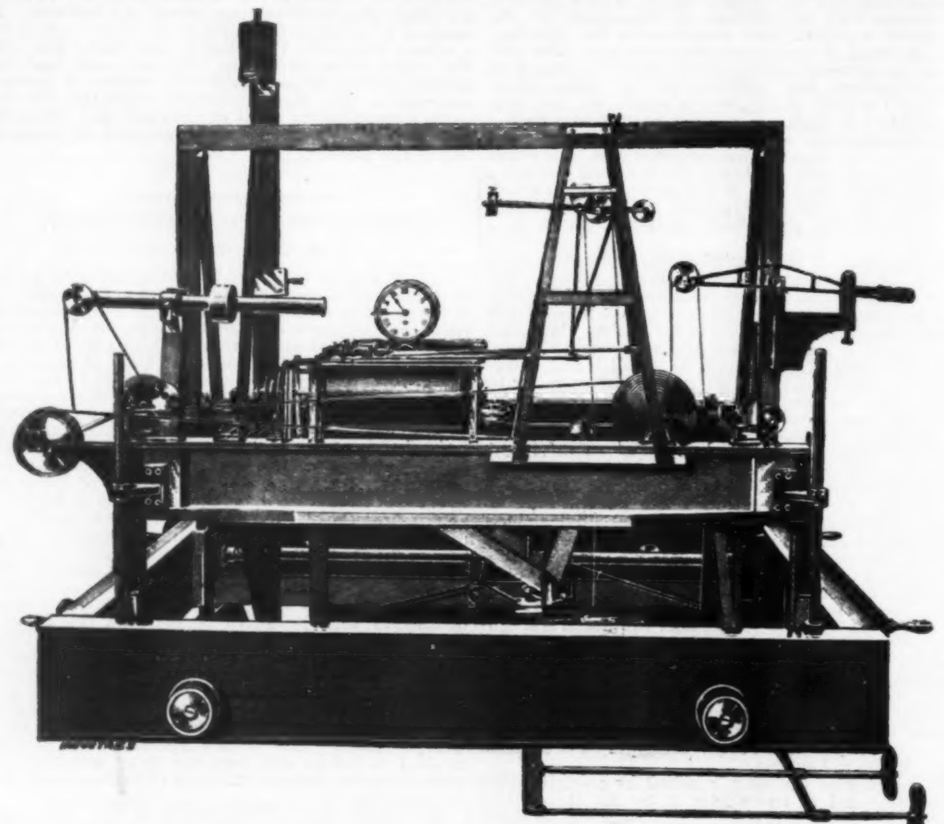


Fig. 1.—Side View of Apparatus.

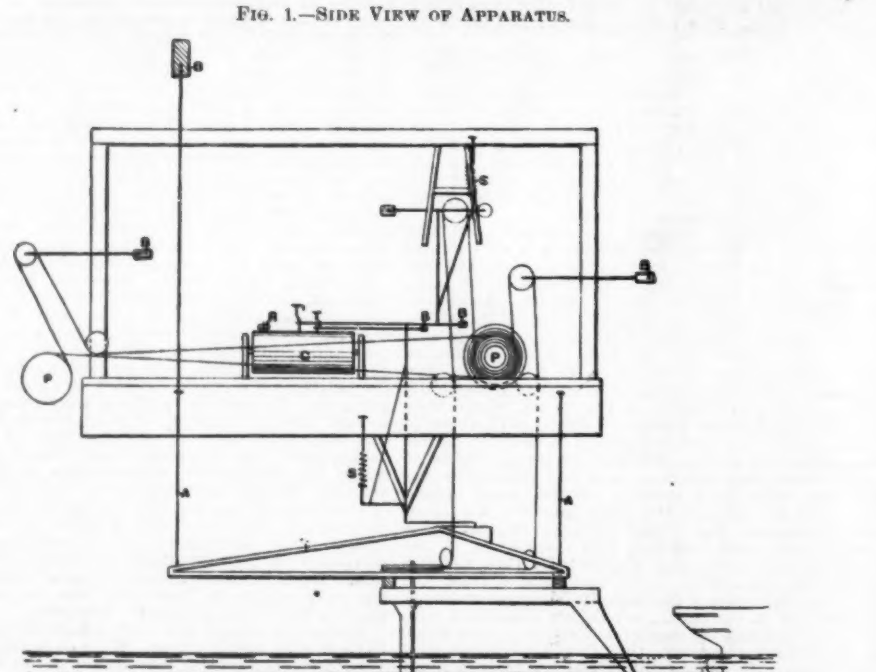


Fig. 2.—Diagram of Apparatus.

APPARATUS FOR ASCERTAINING THE EFFICIENCY OF SCREW PROPELLERS.

"screw truck," or machine for recording the efficiency of propellers, to be used in the new Russian tank, were some time ago completed and dispatched to St. Petersburg by Messrs. Kelso & Co., Commerce Street, Glasgow, who also supplied the apparatus for the tank at Spezia to the order of the Italian government. In design, the new Russian equipment is similar to that in use at Haslar, and the outfit proper comprises the dynamometer carriage, the screw propeller carriage, and the current meter, the latter being specially adapted for recording the currents, or motion of the water in the tank, if there be any.

Three years ago (see *Industries*, February 8, 1889) we placed before our readers a detailed description of the dynamometric apparatus supplied to the Italian tank, which is, practically speaking, identical with that constructed for the Russian government. We are now enabled to describe the screw propeller truck, the primary use of which is to ascertain the most suitable propeller for maximum efficiency, when used in conjunction with a particular form of vessel. The propeller on which experiments are to be made is mounted on a shaft carried by knife-edged brackets and supported by a frame attached to a delicate parallel motion. A vertical spindle at the after end of the frame drives the screw shaft by means of miter wheels, the spindle itself being driven by a series of belts and polygrooved pulleys from the axles of the main truck. This

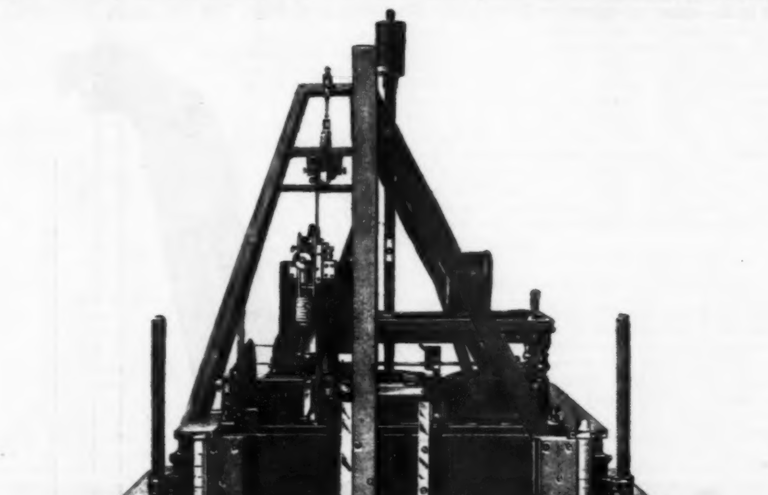


FIG. 3.—FORE END VIEW OF APPARATUS.

APPARATUS FOR ASCERTAINING THE EFFICIENCY OF SCREW PROPELLERS.

main truck, which supports both the dynamometer and screw carriages, spans the entire breadth of the tank, and runs on a railway extending the whole length of the tank at a height of about 18 in. above the normal water level. Any desirable linear speed of advance of the screw through the water may be given by proportionately adjusting the rotary motion of the polygrooved wheels. From Figs 1 and 3 it will be seen that the main framework is capable of being raised or lowered by means of screws—a feature which admits of any desired immersion being given to the screw under experiment. Fig. 2 is a diagrammatic illustration of the apparatus showing the relative position of the screw at the stern of the model ship. A is the parallel motion swinging frame; B B B, the balance weights; C, the revolving cylinder; S S, helical springs for measuring the thrust and turning moment of the screw; T, thrust pen; T^1 turning moment pen; R, revolution pen; and P P, polygrooved pulleys. As will be seen, the parallel-motion framework is suspended by delicate watch springs from the body of the carriage. It constrains the frame carrying the model screw to move simply in a fore-and-aft direction. The whole is so delicately balanced that the slightest force exerted by the screw as a thrust is recorded on a revolving cylinder through the extension of a spiral spring attached to a bell crank lever carrying a pen rod, the bell crank lever being connected by a link to the parallel motion framework (see Fig. 2). Another band passes over a system of delicately suspended levers and pulleys, by which the differences in tension driving and slack sides of the belt are automatically recorded on the same cylinder, and in a similar manner to the thrust. This difference in tension is a measure of the turning moment applied to the mechanism. It may here be mentioned that great care has been bestowed, alike in design and workmanship, with a view to minimizing the effect of friction, especially in regard to the methods of suspending the delicate levers and mounting the various pulleys, many of the latter being supported on friction wheels. In addition to the thrust and turning moment, the revolutions of the screw are also electrically recorded on the cylinder, and as any given speed over the water can be assigned to the propeller carriage, curves of thrust and turning moment may be obtained in terms of revolutions of screw at that speed. From these curves the efficiency at any required number of revolutions may readily be determined.

The screw truck may be used separately or in conjunction with the dynamometric apparatus, and the effect ascertained of the model's presence on the efficiency of the screw or the screw's influence in augmenting the resistance of the model of the ship under consideration. The behavior of either single or twin screws may be obtained in relation to the model, and the best position of the propeller in regard to the hull may be decided upon to realize the maximum efficiency of the hull and propeller combined. In short, with this apparatus the performance of any given screw may be determined, and the most suitable relationship of diameter to pitch and blade area selected, to secure the best results when used in conjunction with any particular form of hull, and this at moderate cost before the ship is actually constructed.—*Industries*.

JET PROPULSION.

THE success which has attended the steam life boat Duke of Northumberland (illustrated in *The Engineer* of September 5, 1890) seems to have stimulated not a few inventors, and we have recently received several letters asking for information concerning jet propulsion, or claiming that the writers have solved all difficulties, and produced something much more efficient as a propeller than either the screw or the paddle wheel. It is worth while, we think, to explain why our correspondents are wrong, and so, perhaps—although we are doubtful on this point—save them from wasting money and time in pursuit of a chimera. The principles involved are very simple, yet they appear to be constantly missed in the most ingenious fashion by inventors, and it is to be feared that certain utterances of the late Mr. Froude taken without their context have proved misleading and beguiling to not a few inventors. The whole subject was dealt with in a masterly article written by Rankine, which will be found in *The Engineer* for November 2, 1866. As that article may be out of the reach of many of our readers, it is advisable once more to explain the principles affecting marine propulsion, and we shall handle the question from a point of view slightly different from that taken by Rankine, who dealt mainly with positive instead of comparative figures.

To begin, it is necessary to explain that the propulsion of ships by steam has nothing in common, as some people suppose, with the action of a locomotive engine. The driving wheels of the latter find fixed points of resistance in endless succession on the rails. The screw and the paddle find nothing of the kind. The reaction in their case is supplied by the weight—or, to speak with strict accuracy, the inertia of the mass—of the water. In all and every case water must be driven astern in order that the ship may move ahead. This statement admits of being proved with as much certainty as any proposition in "Euclid's Elements," but we must beg to be excused from supplying the proof. Generally speaking, it is enough to say that it depends on the fact that water is extremely mobile, and that its friction is very, very small. The resistance which it can offer to an oar, or a paddle, or a screw, is due practically altogether to its inertia. If, for example, a paddle wheel float finds a ton of water at rest, and urges it astern to a velocity of 32 feet per second, the resistance will be one ton, and precisely the same in its nature as that which would be offered to the paddle float by a ton of iron otherwise free to move. A man sitting in a boat can propel her ahead by throwing stones astern. If our correspondents once grasp this truth, they will easily master what follows. Let it then be taken for granted that water must be driven astern, and note the consequences. A portion of the horse power of the engine will be expended in moving the water, another portion will be expended in moving the ship. Obviously, the more power spent in moving the water, the less will be available for moving the ship. We fear that we should defeat the object we have in view if we attempted to treat the question mathematically. Fortunately, it can be mastered by any one with a knowledge of arithmetic sufficiently to satisfy our purpose. It can be shown that the foot pounds of work—the horse power in a word—expended in putting a body in motion in the way that water is put in motion by the propeller varies, not as the velocity, but as the square of the velocity, which is to be measured in feet per second. Thus, if to impart a speed of 5 feet per second to successive portions of matter, so that one portion was moved every second, required 10 horse power; then to double the velocity would require four times the power, or 40 horse power; to treble the velocity would require nine times the power, or 90 horse power, and so on; because to double the velocity requires double the force, and the doubled force has to move at twice the speed. Thus, other things being equal, to double the thrust of a propeller, we must double the pressure on the engine piston and double the number of revolutions. In practice, of course, other things are not equal, and the rule does not hold good, but the statement as it stands will serve to make the principle involved intelligible. It is very easy to see, therefore, that the less the speed at which water is driven astern, the less in a very rapidly augmenting ratio will be the power wasted. So far then two facts are clear. First, every propeller, whatever may be its nature, must move water astern; secondly, that propeller will be most efficient which sends the water astern at the least velocity.

But it is sufficiently obvious that if the quantity of water moved is small, its velocity must be high in order to get sufficient reaction, and it may very properly be urged that whenever we reduce its sternward velocity, we must increase the weight moved. This is quite true, but the deduction constantly drawn by half informed minds is not true. They think that just as much will be lost by moving two tons of water astern at 5 feet per second as by moving one ton astern at 10 feet per second. The truth is that the reaction varies as the weight of the water moved. The rule for calculating the thrust of any propeller is: Multiply the pounds of water operated on in one second by the sternward velocity in feet per second impressed on that water by the propelling apparatus; divide the product by 32·2. The quotient will be the thrust of the propeller in pounds. That is to say, two tons of water will give twice the reaction of one ton of water. The speed remains unaltered, and the power expended in putting two tons in motion will be only twice that expended in putting one ton in motion. To repeat the illustration we have already given, the pressure on the piston must be doubled, but the number of revolutions will remain unchanged. But as we have seen, to get the same reaction out of one ton of water by doubling its velocity, will require four times instead of twice the power. We need scarcely add, that for actual practice our figures need qualification for various reasons; but it is more likely that the power expended in moving water astern will be found to increase more rapidly with the speed than we have stated. The whole theory of propulsion may be summed up in Rankine's words, "That propeller is the best, other things being equal, which drives astern the largest body of water at the lowest velocity."

Now, it is practically impossible to devise any system of hydraulic or jet propulsion which can compare favorably, under these conditions, with the screw or the paddle wheel. Instead of a screw or a paddle, hydraulic propulsion demands either a pump of some kind or a turbine. It would be impossible to fit within a ship a turbine or a pump sufficiently large to deal, at a very slow speed, with the enormous masses of water handled by the screw or the paddle wheel; consequently the pump or the turbine—which is really a centrifugal pump—must impart a relatively high velocity to the water. In the case of H.M.S. Waterwitch, for example, it is said that the velocity of the water escaping at the jets was thirty knots an hour, while the ship was advancing at seven knots. No conceivable efficiency of the pump can mend matters, save in a way which will be made clear further on. A badly constructed pump will waste more engine power than a good pump; but even if its efficiency were equal to 100 per cent. of the engine power, it must still as a propeller be very inefficient, simply because it must of necessity put more work into the water than the screw or the paddle will. Putting this into Rankine's words, the slip of a jet propeller must be enormous compared with that of a screw or a paddle.

There remains to be considered another source of loss peculiar to hydraulic propulsion, and continually overlooked by inventors. The ship finds water at rest as she proceeds. The water enters the pump. It must remain in the pump for an appreciable period, but during that period it is carried forward with the ship, and acquires her velocity; and this action represents a constant resistance to the progress of the ship, and

a great waste of power. To try and make our meaning clear, let us present to the mind's eye of our readers a picture of a tram car with open sides; along the track let some hundreds of men be arranged, side by side; as the car advances, let these men successively jump on the footboard, pass across the car, and jump out at the other side. It is clear that the pull on the horses will be very much increased; because they will have to go on starting men who were at rest into motion at a velocity of say six miles an hour. Each man as he jumps out will find that he has had momentum stored in him in crossing the car, which will tend to throw him down on his side. That has not been got for nothing. In just the same way work is done in continually putting large volumes of water into motion at the same speed as the ship. It is true, however, that the energy imparted in this way to the water is in a measure restored; because the effect is analogous to that produced when a following current in the wake of a ship impinges on the screw. The effect is to augment the forward thrust. If it were not that this effect takes place, then hydraulic propulsion would be so ineffective—not to say inefficient—that it could not be used at all.

We see, then, that everything is against the efficiency of the jet propeller. As far as principle goes, there is only one direction in which it is possible with any faintest hope of success to try to make it better than the screw or the paddle wheel. The function of a propeller is, as we have said, to put water in motion astern. Curious as it may sound, it is no less true that the first duty of any propeller is to move water, not the ship. As far as the propeller is concerned, the motion of the ship is a "by product," so to speak. If it can be shown that a centrifugal pump, or any other pump, when fitted to a particular ship is so much more efficient as a water mover than a screw propeller fitted to the same ship would be—because the superior efficiency of the centrifugal pump will more than compensate for the smallness of the body of water sent astern by it, as compared with that sent aft by the screw—then will the jet be better than the screw, and not till then.

In conclusion, a word of warning is needed. We have repeatedly heard it stated, that by submerging the orifices of a jet propeller, its efficiency is promoted. This is not the case. The work of propulsion has nothing to do with any resistance outside the nozzles. The moment a pound of water leaves the nozzle, its work is done as far as regards the ship. Complete efficiency would be got if the water escaped from the nozzle at precisely the same speed as that of the ship, so that it would fall straight down, instead of rushing astern. It is worth adding, that the best conditions of working are very nearly those obtaining in a turbine or reaction water wheel. In such wheels, when well designed and properly loaded and speeded, the water escapes with very little residual velocity. Such a condition could only exist in a ship if the volume of water was enormous. The centrifugal pump or turbine would, in a word, occupy nearly all the space in the hull. Let us imagine a tube 30 feet in diameter traversing the Etruria from stem to stern, and the screw propeller placed within it. We should then have a tolerably efficient jet propeller; but at what cost? After all, the turbine, or centrifugal pump, or screw propeller, or paddle is better outside in the sea, than inside in the hull.—*The Engineer.*

MOTIVE POWER EQUIPMENT, NEW YORK CENTRAL RAILROAD.

MR. WILLIAM BUCHANAN, Superintendent of Motive Power and Rolling Stock of the N. Y. C. & H. R. R.R., says the *National Car Builder*, has issued a neat little book describing and illustrating the different classes of locomotives in service on that system of roads.

The book is handsomely got up, and the illustrations are all good, most of these being line engravings showing the dimensions of the engines. By permission of Mr. Buchanan we reproduce from his book the following table of train speeds. It is very nicely worked out for all speeds between 30 and 150 miles per hour, and may prove useful to those who occasionally have to figure up train speeds. As Mr. Buchanan has drawn the line in this table at 150 miles an hour it may be taken for granted, we suppose, that this is the limit of speed he intends to reach with his record breaking and world beating engines:

Miles per hour.	Feet per second.	Seconds per mile.	Miles per hour.	Feet per second.	Seconds per mile.	Miles per hour.	Feet per second.	Seconds per mile.
30	44·00	120·0	71	104·01	50·70	111	162·72	32·43
31	45·52	116·0	72	105·60	50·00	112	164·19	32·14
32	46·72	113·0	73	107·06	49·30	113	165·65	31.86
33	48·44	109·0	74	108·41	48·70	114	167·42	31·58
34	49·81	106·0	75	110·00	48·00	115	168·59	31·30
35	51·26	103·0	76	111·39	47·40	116	170·05	31·03
36	52·80	100·0	77	113·06	46·70	117	171·52	30·77
37	54·43	97·0	78	114·28	46·20	118	172·98	30·50
38	55·57	95·0	79	116·04	45·50	119	174·45	30·25
39	57·30	92·0	80	117·33	45·00	120	175·82	30·00
40	58·66	90·0	81	118·91	44·40	121	177·38	29·75
41	60·13	87·8	82	120·47	43·90	122	179·85	29·50
42	61·61	85·7	83	121·65	43·40	123	180·30	29·26
43	63·08	83·7	84	123·07	42·90	124	181·78	29·03
44	64·54	81·8	85	124·52	42·40	125	183·25	28·80
45	66·00	80·0	86	126·01	41·90	126	184·71	28·57
46	67·43	78·3	87	127·53	41·40	127	186·18	28·34
47	68·92	76·6	88	129·39	40·90	128	187·64	28·12
48	70·40	75·0	89	130·05	40·40	129	189·11	27·90
49	71·83	73·5	90	132·00	40·00	130	190·58	27·69
50	73·33	72·0	91	133·33	39·60	131	192·04	27·48
51	74·81	70·5	92	134·65	39·10	132	193·51	27·27
52	76·30	69·2	93	136·40	38·70	133	194·97	27·06
53	77·76	67·9	94	137·86	38·30	134	196·44	26·86
54	79·01	66·7	95	139·05	37·90	135	197·91	26·66
55	80·61	65·5	96	140·08	37·50	136	199·37	26·47
56	82·11	64·3	97	142·31	37·10	137	200·84	26·27
57	83·54	63·2	98	143·86	36·70	138	202·30	26·09
58	85·03	62·1	99	145.05	36·40	139	203·77	25·80
59	86·55	61·0	100	146·66	36·00	140	205·24	25·71
60	88·00	60·0	101	148·13	35·60	141	206·70	25·53
61	89·49	59·0	102	149·58	35·30	142	208·17	25·35
62	90·87	58·1	103	151·00	34·90	143	209·63	25·17
63	92·46	57·1	104	152·46	34·60	144	211.10	25·00
64	93·95	56·2	105	153·93	34·28	145	212·57	24·82
65	95·30	55·4	106	155·39	33·96	146	214·03	25·34
66	96·88	54·5	107	156·86	33·64	147	215·50	24·49
67	98·32	53·7	108	158·32	33·33	148	216·96	24·32
68	99·81	52·9	109	159·79	33·06	149	218·43	24·16
69	101·13	52·2	110	161·26	32·72	150	219·90	24·00
70	102·66	51·4						

IMPROVED TIPPING CRANE.

THE main object of the design of the tipping crane here illustrated is to produce a steam crane which can not only raise heavy buckets of material from one level to another, and perform the ordinary motions of traveling, lifting, and swinging simultaneously, but can also quietly pour out or tip the load at any level, at any angle, or in any direction, whether the crane might be lifting, lowering, or standing still.

The most important requirements and conditions of tipping sought to be fulfilled by the inventor, Mr. F. G. M. Stoney, are, says *Engineering*, as follows:

1. The turning over or tipping action should not in any way depend on triggers, catches, or conditions of balance, and it should be under the absolute command of the steam power in all the evolutions, at the will of the crane driver.

2. The crane should be capable of tipping the bucket in any direction, and to any degree, under complete control of the driver.

3. The engines should never cease to have control of the tipping, and subsequent righting, of any bucket or wagon carrying the load to be tipped.

4. The entire arrangement should be capable of extension to a large variety of purposes.

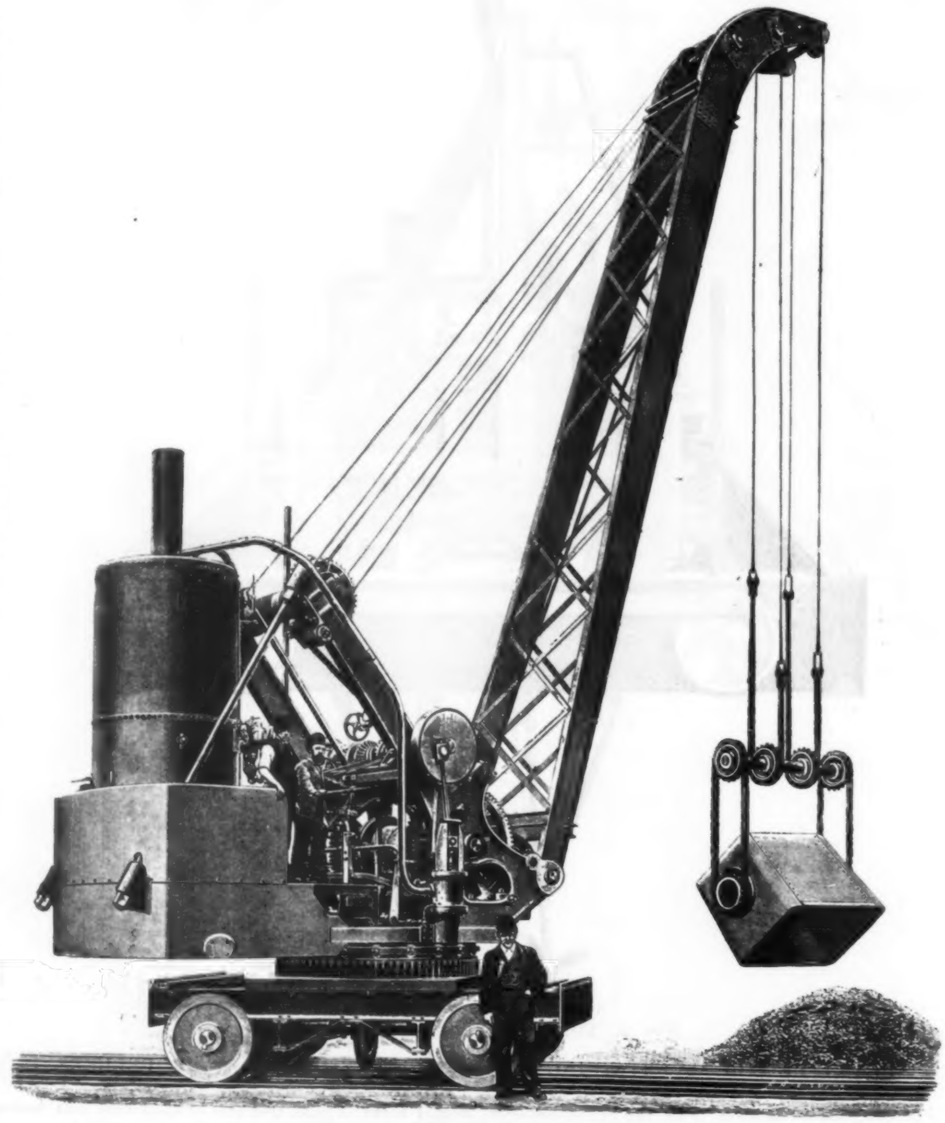
These conditions are fulfilled in a very simple manner, mainly by arranging, in a special steam crane, two barrels, independently driven. These barrels can at will be driven in the same or opposite directions. To render the action independent of conditions of balance as to centers of gravity of variable loads, four steel ropes are used to carry the load. A steel crossbar carrying four sprockets is suspended from the crane in the bights of two short pitch chains, the ends of which are attached to the four ropes. The outer ends of the crossbar are provided with similar sprockets, each of which carries a short loop of pitch chain. The buckets containing the materials to be tipped are provided with like sprockets on their ends, and the endless loops of chains are easily and quickly dropped under these sprockets, thus attaching the load to the crane.

The two ropes fixed to corresponding ends of the short pitch chains are wound as twin ropes, on the double thread groove on one barrel, while the pair of ropes fixed to the opposite corresponding ends of the pitch chains are similarly wound on the other barrel. Thus all four ropes are directly wound by the crane, and so long as the barrels move together in the same direction the load is lifted as in an ordinary crane, but when the barrels are moved in opposite relative directions the load does not lift or lower, but a rotating motion is given to the crossbar, and is communicated to the bucket by means of the two chain loops.

This rotating motion is, of course, performed by the steam power, and is entirely under the control of the driver as to extent and direction. The box may be rotated a complete revolution or more, or only through a few degrees. Also it may be rotated in one direction, and stopped and rotated in the opposite direction.

This facility is of great practical use in many ways. For example, in tipping dredged materials containing water, the water is frequently poured out in one direction, and the solid materials afterward tipped in the opposite direction. Similarly, in tipping into trucks, it has often been found convenient to tip part of the load in the direction of one end of the truck and the remainder in the other direction; this is easily performed by simply reversing the engines. Several of these cranes are at work on the Manchester Ship Canal, dealing with vast quantities of dredged materials of all kinds, varying from sand to rock.

It might appear at first sight that there would be some delay in attaching the chain loops to the sprockets on the boxes, but this operation proves to be of the most simple character, requiring no skill, and occupying not more than one or two seconds of time. So great, indeed, is the facility of handling materials in this way that as many as 312 boxes (each containing 6 tons of dirt) have been lifted from barges to a height of 25 ft., swung round, tipped, and the boxes placed back on the barges in a working day of 9½ hours by one crane. This represents over 62,000 foot tons of work, in addition to the duties of traveling, swinging, and tipping. By means of such cranes a great saving of time and labor might be made in the coaling of ships, but the more important feature in this business would be in saving the coals from being so much broken and knocked into dust as they are by the ordinary systems hitherto adopted.



IMPROVED TIPPING CRANE.

With these cranes, boxes of coal can be lowered into the holds of ships and gently poured out with the least possible damage to the coal, and in such directions as to save trimming to a very large extent. In like manner, trucks could be lowered into ships having large hatchways, and the contents gently emptied in any desired direction, so as to avoid or reduce trimming.

These cranes on the Manchester Ship Canal have now handled some millions of tons, and are working day and night with double shifts of men, handling these vast quantities of materials at a very low rate of cost per ton. The cranes are made in two sizes: Size A, 10 ton crane, to handle quickly, and at a long radius, 4 yard tubs; size B, 6 ton crane, to handle 2 yard tubs.

A NEW method of producing steel has been suggested to M. Jules Garnier by M. Moissan's diamond-making experiments. He claims that it is successful. The steel is instantaneously made by placing a bar of iron and a stick of charcoal together in a parallel direction in an electrical firebrick furnace of a temperature of 1,000 degrees and subjecting them to a strong current. M. Jules Garnier expects that his discovery will revolutionize the steel industry.

MODERN MILLING.*

By JAMES NEWBY.

IN looking over the past history of milling methods, from 1850, when the millstone was used, with its one reduction, hopper boy, shoe feed, knockers and reels forty inches in diameter with different grades of cloth, making all the separations on the same reel, and following up the stages to the present time, I see that our advancement is, indeed, wonderful. A miller must be continually on the alert to keep up with the march of progress, or he will awake some fine morning to find his neighbor ahead and his trade gone. Our countrymen are growing more refined in their tastes and are always looking for the best goods on the market.

To hold trade we must make flour uniform in quality; the mill must be kept in perfect order, the rolls, reels and cloths nicely adjusted and frequently looked after, while special attention should be paid to the grain-cleaning department, so often neglected. To produce good flour it is of the utmost importance that we have sound, well cleaned grain of the proper mixture to give the desired results. Upon receiving a load of wheat, note the locality in which it was raised, and the quality, soft or hard. Weigh, and send it to a good machine for separating light materials, then to the weighing hopper and a second cleaner for final purifying before conveying it to the proper bin. The storage system should be so arranged that each grade may be separate, to be drawn from according to the mixture needed in the quality of flour to be made. Having selected such a mixture as is required, run it to the magnetic separator, then to the milling separator, scourer, brush and rolling screen with fan attachment.

We have now arrived at our first reduction. This should be carefully made, as the systems used will control the reductions in the mill. They are three in number, the short, medium and long, all claimed to produce good results. Mine will be for a five to six break on grain, with ten or more on the remainder of the stock. If you have a five-break mill, start with from ten to twelve corrugations per inch, and break down quite hard, so that you may produce ten or twelve drachms of flour and middlings per ounce of break stock. To obtain the best results from breaks, and to equalize the amount of work done by them, I have found it advisable to use a small scale for testing the breaks. It requires a little time to weigh and separate, but it pays. I have, also, a scale for weighing the flour and water used in doughing. After a few trials one can detect very quickly whether the mill is working softer than usual, the wheat changed in quality or the millers grinding closer than they should.

The short system requires simpler bolting methods than the medium or long. This is not because it is short, but because the reduction made is. All the material is soft and the middlings finer and less. Less scalping is required as the grades of stock are less. Gradual reduction means a longer system; the flour made is incidental. The short system disregards the making of middlings to a great extent and presupposes more flour. On the first reduction there are two short systems, one retaining the middlings idea, the other rejecting it. The gradual reduction method refrains from making flour until it reaches the fourth, fifth and sixth reductions, making all the middlings possible on the former reductions and begins to make its best flour after it has started on the middlings.

The difference between the systems is: That in the gradual we are not in as great haste to reduce our middlings as in the short. The long produces as large an amount of middlings as possible, the short more flour; the latter, of course, requires fewer separations. The material, also, differs in character; the middlings are fewer and finer. Sizings are but little known, as, in reduction by the short method, they are, practically, done by the breaks. The long system retains the middlings idea and continues purifications and separations. By this plan we have larger germ middlings to be sized and separated. In reducing these germ middlings care should be exercised in having a good separation of the product. The head of this reduction can go to the patent. If it be desirable, the next cut-off may be sent to the reel for dusting, so that the finer middlings may go to the purifier, the cut-off near the tail to the A sizing rolls and the next to the second, the tail going to a duster.

We must have a correct and uniform feed. If it is not, an uneven stock is produced, and low grades are multiplied. Our first rolls were crude in this respect. The most perfect feeding device for breaks is a vibratory apparatus, the stock passing over tables and spreading itself in uniform sheets. It needs very little attention and gives a nicer granulation, with more perfect separations. This is most important, though three-fourths of the millers do not appreciate the fact.

Milling is still in a state of evolution. The systems in use at present will be superseded, I feel assured; rolls will still be used, but great strides will be taken in the handling of the stocks and their purification. As we are getting more perfect dust collectors I think we may soon begin to elevate our stocks with air. I used this method in 1866 with success, in cooling the flour and giving it a better color. Our millers are far ahead of the Europeans, being quicker to see an improvement and to take advantage of it. The period of secrecy in milling is past. The system now in use, of reductions and separations, has been brought to the front and investigated. Practice has given us a good system, though it still leaves much to be desired. In all our reductions and separations we should avoid sending the stock too far in elevators and conveyors, as this wears off particles and produces a soft, pasty flour.

I do not purpose to say which system is preferable. To work any correctly, one must understand all of its points and the mill. It would be folly for the miller to reduce his stock in a long system mill upon the same lines as in a two or three break system. Of course, the use of the former admits of greater skill in the manipulation of separations, while the latter grinds the stock to death as fast as possible.

It is a very easy thing to spoil the good working of a mill by an improper adjustment of the rolls or by neglecting purifiers and separators. Millers sometimes allow good middlings to get to the end of the mill by not grinding properly, or by not watching all the separations. I would suggest that all millers, when they have nice, clean middlings, should get them into the flour by the shortest route possible. I prefer a finely corrugated roll for this work, as it gives more flour at one reduction and leaves more granular stock for further purification and reduction. Moreover, I make the separations such as to enable me to use about the same numbers of cloth for all of my flours.

It will be impossible for me to fix a definite system of bolting and scalping with the necessary separations as long as we have so many different modes of milling. Whatever system you use, look well to your corrugating; keep the rolls in perfect trim, having the journals fit closely in long bearings, with large pulleys, wide belts and good differentials. Have the rolls dressed often, and, with an attentive miller, you cannot go far astray. Never allow him to run the rolls so as to flake the stock; always grind so that you can feel its granular condition, which should be lively. Bolt and separate freely, as by this means we obtain a better body to the flour. This holds good throughout the mill. If you are running on the middlings idea, I would use the saw tooth corrugation back to back on the first reduction; on the second, the saw tooth running sharp to sharp; on the third, a compromise, the saw tooth on one roll and a corrugation between a round and a sharp on the other. This reduction is as far as I draw good middlings for the first purifier for the best grades of flour. The remainder of the reductions are made by saw tooth rolls running back to back. The rolls should have a good motion, with a differential of two and a half or three to one. After the separations are made, before blending the grades, I would recommend that the flour be run through air currents to cool and bleach it. The successful miller is a man of broad views and advanced thought. He does not cling to old ideas of separations, neither does he adopt all the new wrinkles. He looks about him, reads, investigates and compares. As I have said, we are in a progressive age, and the profitable way is to keep up with the procession.

* Abstract from a paper read recently before the Pennsylvania Millers State Convention.—*Millers' Review.*

BLEACHING COTTON YARN.

THE cotton, which should not be previously soaked, is tied in bundles to chains and is introduced into the wooden or iron caldrons; it is placed round the upper and overflow pipes in the center of the vessel, covered with packing canvas, and heavily weighted so as to prevent the chains from being carried upward when the water is put in; this is done from the top, and enough cold or, what is better, warm water is admitted to cover the yarn. While this is being done, soda is dissolved in hot water, in the quantity desired, and run through a linen filter suspended over the caldron on to the yarn, any impurities in the soda being intercepted by the linen.

For every 1,680 pounds of cotton there are used 84 pounds of calcined soda (82 per cent.), or 71 pounds of ammoniate of soda (98 per cent.), or 189 pounds of crystallized soda (37 per cent.), or 50 pounds of hard caustic soda, sometimes called the hydrate of soda. It is not desirable to use a smaller quantity; too weak bucking would involve the use of too strong chlorine later, which would be a source of danger to the yarn, and cannot take the place of boiling under proper conditions. It is evident that caustic soda is at once more powerful and more rapid in its action than carbonate of sodium, while it immediately saponifies the cotton oil which is present in the yarn. Still, many a bleacher has an unreasonable aversion to hydrate of soda, because he fears that it may attack the cotton threads.

Danger to the strength of the thread need not be considered (and it is a matter of indifference whether caustic soda or carbonate is used) until the oxygen of the air acts on the yarns, which have absorbed the alkaline fluid; that is to say, when there is not water enough in the caldron to guard them from contact with the air. If it gets at the hot yarns in the upper part of the caldron during the boiling, or after the boiling while the water is still hot, the oxygen attacks the fiber and weakens the thread, in consequence of the formation of oxycellulose. It is well to see that there is enough water in the caldron before closing it, and, if necessary, to let more in until the yarns are covered to a depth of from 8 to 12 inches of the bucking fluid, so that they are lying in about 2,100 quarts of 2° Bé.—a strong alkaline bath, which, with its 2°, is in complete accord by great good luck with the proportions of weight and mass above given.

When the vat is closed the steam rushes in freely under its bath bottom, the bucking fluid becomes warm, rises high in the overflow pipe, begins to boil, circulates through the yarns from the top downward, and pours over them a continuous flow of fresh, boiling liquid from a point close to the lid, over the upper pipe throughout the vessel. The time allowed for the real boiling is taken from the moment the liquor begins to boil. In wooden vats, nine to ten hours are given; in iron caldrons, with steam pressure five to six hours are given. In both cases the exclusive use of caustic soda admits of the shortening of the time of boiling by from an hour and a half to three hours.

It is of the greatest importance that the yarns should remain overnight in the hot bucking fluid, although it is not kept at boiling point: on the following morning hot, and then cold, water is run through them in the tank itself. Even that washing is not enough; the yarns must be washed clean in running water, or washed by hand in a trough, or passed through a yarn washing machine, or slightly fulled in the hammer-fulling machine. They are then passed through the hydro-extractor to be wrung out, for it is only in the smallest business that the wooden peg can take its place.

The 1,680 pounds of boiled yarn are divided into four parts, when the chains are undone, in order that they may be put, bundle by bundle, into a dilute solution of chloride of lime in four wooden or other reservoirs. Such a quantity as 1,680 pounds of yarn requires on an average 52 pounds of powder of chloride of lime, which contains 25 per cent. in weight of chlorine. The state of the chloride of lime differs considerably, as is well known, depending on where it is manufactured, on its strength, and on the care with which it is looked after in the bleaching store room. The day before the chloride of lime is used it should be put in a reservoir of masonry of about a cubic meter in extent, carefully stirred up with water, or, what would be better, dissolved with the mixing sieve machine, and diluted with just enough water to make the solution indicate about 3° Bé. after it has been allowed to clear. With that as the starting point, the four chloride of lime baths are arranged to vary between 0·3 and 0·7° Bé., depending on the number of the yarns which are to be bleached.

The determination, according to the degree on the hydrostatical balance, is by no means all that is required for the intelligent carrying on of the business, and for the reason that fresh chloride of lime baths are not always employed; but very often a solution of greater strength is used when it is not desired to waste chloride of lime. As a matter of fact, the chloride of lime bath is only half used up by the yarns that have been in it, and by the addition of a fresh solution it is soon got in order for the next lot of yarn. Keeping that object in view, it is indispensable that not only the chloride of lime solution, but the bleaching baths prepared with it, should be tested before use, not with the hydrostatical balance alone, but also by titration, to ascertain the amount of chlorine present.

The most popular and also the handiest way of making this test is with arsenious acid and sodium, using sulphuric acid and indigo as indicator. When the quality of the fluid has been established by an expert chemist, the test can easily be learned and applied by an intelligent workman. A detailed description of this process of titration is superfluous, as it can be found in any good text book of chemistry.

The chlorine bath for each of the four lots of yarn consists of about 3,600 quarts of fluid, with the required amounts of chlorine for the respective numbers of threads. The yarns are sorted into lots and then lightly thrown into the bath, bundle by bundle, so that they nowhere press on each other, and the fluid has undisturbed access to each bundle. They are left lying in the chloride of lime at least 4 to 5 hours, but oftenest overnight, whereupon the fluid is pumped out of the chloride of [illegible] reservoirs into empty reservoirs; but the [illegible], after being left some time in the reservoir for the fluid to drain off from it, is taken out and thrown direct into the acid. Considering the weakness of the chloride of lime baths, another water before the acids is not desirable, either for the workmen or for the cotton threads.

The chloride of lime bath must be clear and transparent. Should the chloride contain too much hydroxide of calcium, or should the yarns not have washed clean after the boiling in carbonate of sodium solution, the chlorine bath becomes cloudy, and it must be made clear before use. A little sulphuric acid sets this right. Many bleachers overdo this acid addition in order to make the solution more effectual, but in so doing they are entering on a dangerous path, which, in the writer's opinion, gives a poor prospect of success.

A number of experiments on a small scale have made it clear that the addition of sulphuric acid to increase a chlorine bath which, it must be understood, is still further weakened by water, uniting the chlorine bath with the acid bath in order to save the special acid bath, has led to a negative result. As long as the yarns remained in the chloride of lime bath with a sufficient amount of the misplaced sulphuric acid, they were a splendid glittering white in the greenish liquid. But as soon as they were taken out and rinsed in water, they soon assumed a sort of yellow color, which become yellower still the more acid was added to the chloride of lime bath, without the threads being weakened, however. This astonishing fact can only be explained on the supposition that the thread in the acid reaction of the fluid shuts itself up, and so it is bleached only on the surface; then on being washed in water, with the disappearance of the acid reaction, it opens itself out, and the inner and unbleached portion of the yarn comes in sight, while the ordinary weak alkaline chloride of lime bath seems to act in opening the cotton thread, and to give the chloride of lime free access to the inside of the yarn.

The four lots of yarn require, together, thirty-three pounds of sulphuric acid of 66° Bé. (with 98·5 per cent. H_2SO_4), which is divided between four vats equally, in about 2,800 quarts of water. The yarns are then lightly thrown into this diluted acid. They are left there four hours; then the acid bath is drained off. They are softened three times in the acid vat with water containing soda, and then washed clean in running water in the trough, or by the washing machine. While it is impossible to establish any proportion between the expense and the danger which the usually weak acid bath with each successive lot of yarns incurs in having considerable additions of chlorine, it is recommended, in the interest of the yarn, that the acid once used should be run off and not used again, as is done in the continuous bleaching of piece goods. If the washing is done in the trough, it is well to throw in a little anti-chlorine or spirits of sal ammoniac from time to time.

The perfectly clean washed bundle is next given a blue tint in an ultramarine water. The nicest blue is produced when the yarns are got into the blue water completely free from acid. Otherwise they are apt to be gray and cloudy in coloring. The ultramarine blue must be carefully mixed with water, well distributed through the water, and bolted through a fine cloth before being put in the blue trough. After having been given the blue tint, the yarns are dried in the centrifugal drying machine—when the weather is fine in the open; when it is unfavorable, a warm drying room is had recourse to, or they are dried on the yarn drying machine, packed and sent to the yarn press.—*Kielmeyer, Deutsche Faerber-Zeitung; Textile Record.*

ORNAMENTING OF WATERPROOF FABRICS.

ANY suitable woven fabric is coated with India rubber proofing, and is then covered or partially covered, according to the design and effect it is intended to obtain or produce, with spun or twisted threads formed of any desired fiber, as silk, cotton, etc. These threads must be laid more or less closely to and parallel with one another in straight lines lengthwise of the fabric, or they may be arranged so as to form stripes, or zigzag lines, or in any other manner to pro-

duce the desired design. The threads are made to firmly adhere to the proofed face of the fabric by pressure, by first passing such threads through an India rubber solvent, and then pressing the threads onto the proofed face of the fabric by passing the latter between calendering rolls, after which the fabric is rolled up tightly and left in this condition until the solvent has softened the proofing, when the fabric is again passed between pressure or calendering rolls to cause the threads to firmly adhere to and become partly embedded in the proofing.

The threads, when no solvent is applied, may be fed to the fabric by any desired mechanical devices. They may, for instance, be drawn from bobbins or warp beams and guided by a weaver's reed to the fabric in the spreading machine at a point where the proofing has sufficiently dried, but has not become too dry, to prevent adhesion of the threads thereto, which are pressed onto it, and the proofed fabric with the thread adhering thereto may then be passed between calendering rolls to consolidate such threads with the proofing.

In some cases the threads before being applied to the proofed face of the fabric may be coated with what is commonly termed a rubber solution, that is to say, a rubber solvent in which pure rubber has by preference been dissolved, or the proofed and thread-ornamented fabric may be coated with one or more thin coats of proofing spread thereon in the usual manner in the spreading machine; but in this case, or when the threads are first coated with a rubber solution, the luster of such threads as silk and the like is more or less destroyed or spoiled, and these latter processes are only advisable for inferior goods where the best ornamental effects are not required.

When the design is formed by wavy or zigzag lines, the thread guide (reed or the like) has the required motion imparted thereto by any suitable mechanism.

The thread-ornamented water proofed fabrics are finished in the usual manner by having farina or similar material applied thereto, and are then vulcanized. If vulcanized by the ordinary cold process by means of bisulphide of carbon and chloride of sulphur, the farina is or may be applied immediately after the vulcanizing liquid has been applied to the proofed face of the fabric.

By means of the described process beautiful designs in imitation of woven goods and brilliant effects can be obtained without materially increasing the weight of the fabric.

LINSEED OIL FOR PAINT AND POLISH.

LINSEED oil when it is poor, thin and weak in quality is but one-half its former self, and bad; but when it is adulterated with fish oil, cotton seed oil or petroleum (known in the trade as neutral oil), it is a pickpocket that will rob both you and your customer. I attribute the greater part of the trouble with bad paint to bad, adulterated linseed oil and turpentine. I have heard of a jobber who placed an order for two hundred barrels of turpentine, each barrel to be adulterated with twenty per cent. of kerosene oil.

In the suburbs of our large cities, where frame buildings are the custom, the practical man can immediately detect, after a few months have elapsed, the ready-mixed fraud, the linseed oil substitute fraud and the silicate fraud. Each one has its peculiar look, and our enterprising manufacturers have their contracting master painters liberally distributed in all parts of the country. Their knowledge extends only to the brushing on of these compounds. From the practical point of the house painter I consider that linseed oil is the life of the paint; without it the substance could not be called paint. There is no other medium within the knowledge of the trade of equal value. It has all the requisite properties to hold the pigment, to spread evenly and wear a reasonable length of time. Good oil gives general satisfaction.

Linseed oil is from the seed of the flax plant from which linen is made. It grows in all parts of Europe, in the Western States of America, India and New Zealand.

LINSEED OIL POLISH.

It is well known that linseed oil is the base of almost all varnishes, and is used with shellac and alcohol to make the famous French polish. It may not be generally known that linseed oil in itself will make the most lasting polish that can be made. It was quite a common polish in the olden time, and was used especially for polishing the tops of dining room tables, because of the brilliancy of the polish and its ability to resist a great heat. The hottest dish could be placed on it without marring it in the least. The mode of producing this polish will show the nature of linseed oil in itself. The first coat is laid on with a brush and well rubbed into the wood; rubbed until the wood is almost dry. The second and all succeeding coats are rubbed on with a pad, and not only rubbed on with a pad, but rubbed dry with a pad. About one week is allowed between each rubbing. As the polish makes its appearance the surface is sponged with cold water and rubbed dry before each oil rubbing. This is continued for six months or a year, until the job is complete. The main features of this polish are the oil and the rubbing or polishing. I question if the modern science of varnish making has produced a varnish that will stand the test of the linseed oil polish. In this polishing operation there is something to be observed that will apply to our everyday work. It shows that thin coats well brushed out with plenty of time to dry and harden between coats make the most permanent job.

We are told that in drying, linseed oil gives off some elements and takes on others; notably, it gives off water and takes on oxygen; this is what produces the leather-like substance when it is dry. The pad passing to and fro over the surface of the table produces heat, which dispels the water and leaves a fresh surface of oil to absorb oxygen. This is the drying, or, I should say, the transforming of linseed oil from a fluid to a semi-solid state. After the first gloss is produced by rubbing, the oil does not readily take to the surface. Water acts readily on linseed oil; it opens up its surfaces, as it were, and fits it to amalgamate with the next coat of oil and rubbing.

LINSEED OIL IN PAINT AND VARNISH.

On this subject an interminable discussion may be indulged in, as every painter and paint and varnish maker has a theory of his own; therefore, all I can offer is my own theory, from a practical standpoint, not a chemical one, as I lay no claim to chemical knowledge. We find the varnish maker uses the same principle in preparing oil for varnish as is used in the oil polish; heat, to dispel the water in the oil, and oxygen in the form of manganese, litharge, etc., to harden his oil. The gum stands for the body or number of coats. According to the quality of the gum and quantity of oil will be the quality of the varnish produced. The oil, as Mr Hopner truly says, is nine-tenths of the virtue of the varnish, for when sun and storm eat out the oil the gum stands for nothing.

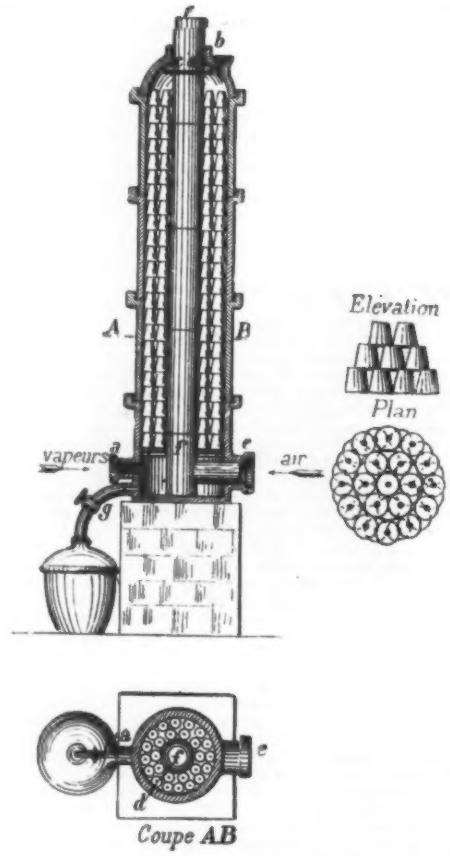
Linseed oil in paints, its use and abuse, is the most essential knowledge a painter should possess, and can only be acquired by careful study and close observation. Any theory advanced on the subject will be disputed by interested parties.

In paints for inside work, or to be protected by varnish, the minimum quantity of oil is used. In paints for outside work the oil is the standing quality or virtue of the paint; and, as in varnish, the quantity of oil and the quality of the pigment determine the life of the paint, to which must be added knowledge of the surface to be painted and the proper proportion of oil and pigment suitable to the surface. This knowledge all practical painters should possess.—*James Marks, in Painting and Decorating.*

NEW CONDENSATION APPARATUS.

THE condensation of vapors is a very frequent industrial operation, but almost always costly and difficult to perform.

The apparatus devised by Mr. E. J. Barbier is so simple and at the same time so efficacious that it can be usefully and especially economically employed, not



FIGS. 1 AND 2.—BARBIER'S CONDENSATION TOWER.

only for effecting condensations of vapor, but also for performing a certain number of physical and chemical operations upon gases.

It is based upon the principle of the multiplicity of surfaces of friction through the use of very small condensation and reaction chambers. It consists of a tower filled with cells made of a durable material adapted to the purposes for which they are to be used—metal in certain cases and pottery, sandstone or glass in others.

These cells have the form of small conical pots with a hole in the bottom. They are packed in the tower in superposed layers, care being taken to always leave the orifice in the bottom of each cell free. The arrangement is shown in plan and section in Fig. 1.

In order to still further favor the condensation, the edges of the aperture in the bottom of the cells are slightly turned up. In this way there is retained upon each bottom a thin layer of liquid which arrests the dust carried along.

The size of the pots varies according to circumstances. The mean type measures 0·08 m. at the mouth, 0·06 m. at the bottom and 0·08 m. in height. It corresponds per cubic meter of filling to 1,750 piled up pots and to a surface of friction of 75 square meters.

It will be readily seen that such a tower must present a great power of condensation. Besides, its numerous cells constitute so many reaction chambers that the fluids are obliged to traverse in making thousands of detours before reaching the exhaust chimney.

As for the draught, that is always effected under good conditions, for the section of the orifices through which the gases pass represents at a minimum a quarter of the total transverse section of the tower. In the case of the condensation of vapors, the cooling is further aided through chimneys in the center of the tower through which a current of cold air is forced (Fig. 2).

All vapors that are condensable by friction, cooling, contact with a liquid or absorption may be successfully treated in this apparatus. Let us mention the adaptation of the tower to the roasting of sulphureted ores. The gases issuing from the furnace traverse the cells in abandoning therein the solid substances carried along, and the sulphurous acid is condensed by means of a spray of cold water, the discharge of which can be regulated at will (Fig. 2).

The dissolved sulphurous acid is collected, while the non-absorbed gases escape through the chimney. Sulphurous anhydride can afterward be prepared by the ordinary processes. The Barbier tower can likewise be utilized for the conversion of sulphurous acid into sulphuric. Mixed gases may also be separated economically by producing absorptions by properly selected gases or liquids. Thus, in the treatment of sulphureted ores containing arsenic, the sulphurous acid is collected, as has been explained, and the arsenic is separated by means of a current of hydrosulphuric acid, for example, which, circulating in an opposite direction, condenses the arsenical vapors in the state of sulphide of arsenic.

The condensation of gases mixed with air, which constitutes one of the most difficult operations of industrial chemistry, is rapidly and economically effected by the use of two Barbier towers with douches.

In the same conditions it is possible to very simply condense nitrous and sulphuric vapors, the vapors of arsenic of arsenical pyrites, hydrofluosilicic acid, etc. In order to condense nitric acid, two towers are employed. The first preserves heat enough to condense only the vapors of nitric acid, while the nitrous vapors pass into the second tower with the chlorine and a good portion of the aqueous vapor. This arrangement is represented in Fig. 3.

It is possible also to effect a purification of illuminating gas and poor gas by cooling them and condensing the sulphurous and ammoniacal vapors and the tars.

The apparatus may be substituted with success for the condensing chambers at present employed in the metallurgy of mercury.

Finally, the Barbier tower will prove useful for the condensation of the smoke of manufactories in cities,

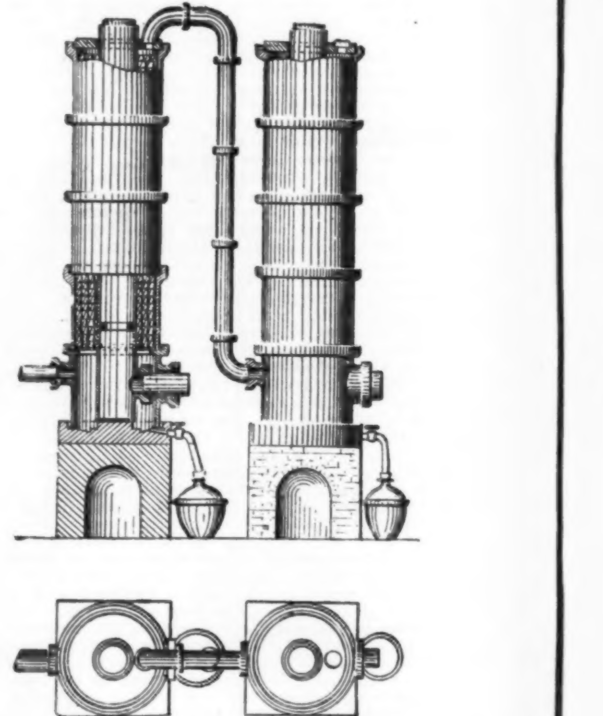


FIG. 3.—ARRANGEMENT FOR CONDENSING NITRIC ACID.

a problem that has already given rise to numerous researches.—*Le Genie Civil.*

THE SOAPSTONE INDUSTRY OF CHINA.

THE British consul at Wenchow in his last report gives some interesting details respecting the manufacture of steatite or soapstone ornaments in China. The mines are distant 42 miles from Wenchow, and are reached by a boat journey of 35 miles up the river, followed by a land journey of seven miles over rough ground. The hills containing steatite are owned by twenty to thirty families, who in some cases work the mines themselves, in others engage miners to do it on their account. The galleries are driven into the sides of the hills, and are often nearly a mile in length.

The composition of the hills is soft, and the shafts require to be propped up by supports of timber; for the same reason the floors are full of mire and clay, so that the miners wear special clothing, made principally of rhea fiber. They lead a hard life, living in straw huts on the hillside. The stone when first extracted is soft, hardening on exposure to the air. It is brought out of the mine in shovels, and is sold at the pit mouth to the carvers at a uniform price of about ½d. per pound. This would be when the purchaser buys it in gross, without first selecting it in any way. When picked over the mineral varies very considerably in value—according to the size of the lump, its shape, and above all its colors.

The colors are given as purple red, mottled red, black, dark blue, light blue, gray, white, eggshell white, "jade," beeswax, and "frozen." Of these "jade" (the white variety, not the green) and "frozen" are the most valuable. Indeed, so valuable is the latter, that good specimens of it are said to fetch more than real jade it-

self. The industry finds employment at the present time for some 2,000 miners and carvers. A great impetus was given to it by the opening of Wenchow to foreign trade.

Previous to that event the chief purhasers of soapstone were officials and literary men, and the article most often carved was a stamp or seal. When it was discovered that foreigners admired the stone, articles were produced to meet what was supposed to be their taste. Such were landscapes in low or high relief, flower vases, plates, card trays, fruit dishes, cups, teapots, and pagodas. If left to his own devices the native carver proceeds first to examine his stone, much as a cameo cutter would do, to discover how best he can take advantage of its shape and shades of color. There is for this reason room for wide difference in artistic quality, apart altogether from the intrinsic value of the mineral, and carved pieces vary in price from a few cents to £3 and upward. And among the more pure native articles produced are, besides the seals, writing materials, such as trays for pens, slabs for rubbing ink, and the like; flower vases, square, round, or hexagonal; boxes for sealing vermilion, incense boxes of all kinds, but chiefly have the character for "long life" in open work on the cover; small sandalwood burners, flower baskets and balls, candlesticks, chessmen (or as we should regard them, draughts), cups, bowls, and lamps; idols, as the Star of Longevity, the Eight Genii, Goddess of Mercy; lions, monkeys, and other animals. Less ambitious workmen content themselves with polishing the stone and cutting in relief certain common emblems, as the sun, moon, clouds, mist, the lute, chessboard, books, scrolls; or the character, for happiness, promotion, old age, and posterity. It is said to be a peculiarity of the retail business that these goods are to be purchased more cheaply from house to house peddlers than at the mines. The reason given is that the excessive weight of the material makes the peddler glad to dispose of it at any price. But the facts may be quite otherwise, and the story an ingenious concoction in the interests of the peddlers.

TWIG FORAGE.

THE name of "twig forage" is given to a fagot formed of the sprouts of the year, gathered either in the spring or at the beginning of autumn, and of the branchlets bearing such sprouts. This product having been found suitable for feeding cattle, the administration of forests has just conceded to Mr. S. Kuhn a site in the domanial forest of Senart for the exploitation of it. Two other similar manufactories will be established before long, one of them at Meudon.

This creation has so much the more importance for agriculture in that the extraordinary drought that marked the beginning of the year and which caused a dearth of forage may be renewed. Now the gathering of twigs escapes all the unfavorable conditions to which other forages are exposed. On another hand, there would result from the use of this forage a saving in straw, which would be an encouragement to breeding, the straw then being capable of being reserved for litter. But it must not be forgotten (it is a question here of twigs only) that the young organs of plants, leaves, shoots and branchlets can alone be utilized for the feeding of cattle.

Mr. L. Grandeau, director of the agronomic station of the east, who called the attention of breeders to this question last year, has been good enough to communicate to us the result of his researches. *Apropos* of this, he recalls that tree leaves have been employed as cattle food from ancient times. Pliny the elder and Cato, in the *de re rustica*, point out the services that they are capable of rendering in this respect. The idea of utilizing branchlets was put in practice for the first time more than half a century ago in Savoy and in the department of Ain. Some of the Austrian foresters of Berg and Wessely likewise have been engaged in this practice for thirty years past, and, more recently (1892), Mr. Grandeau has, as we have stated, pointed out this valuable resource. The merit of having brought it into the domain of practice is due to Mr. Emile Ramann, professor at the forestry school of Eberswalde, and to Major Jena. The experiment was made several years ago in Germany upon large game by Mr. Neumeister and upon horses, oxen and milch cows by Messrs. Biebrach at Hedille, Jena at Coshen and Salisch at Postel.

Mr. Kuhn's establishment is situated upon the territory of Montgeron (Seine-et-Oise), at the entrance to the forest of Senart. The shed under which the machines are placed stands near the route from Paris to Lyons, which fixes the boundaries of the communes of Brunoy and Montgeron at the place called the Pyramid. Some forty woodmen gather the twigs of oaks, beeches, birches, wych-elms, lindens, etc., and make small fagots of them, which are carried by wagons to the factory, where they are placed in a pile. When the moment for utilizing them arrives, the binding cord is cut and the branchlets of which the fagots are composed are placed upon a table and thence pass into the machine that is to crush them. This machine, which is actuated by a petroleum motor, seizes the twig, cuts it by means of a blade, and then delivers it to two superposed cylinders that are designed to divide the twigs that have been cut to pieces by the knife. The twig thus treated, and the leaves of which remain entire, then escapes through a hopper and falls upon the floor. This mechanism, which is as simple as it is ingenious, has the advantage of perfectly cutting up the twigs, which, divided lengthwise, are soft to the touch. The product obtained, the aroma of which puts one in mind of tea, has the aspect of a mixture of chopped straw and hay of a greenish color, becoming slightly yellowish with time.

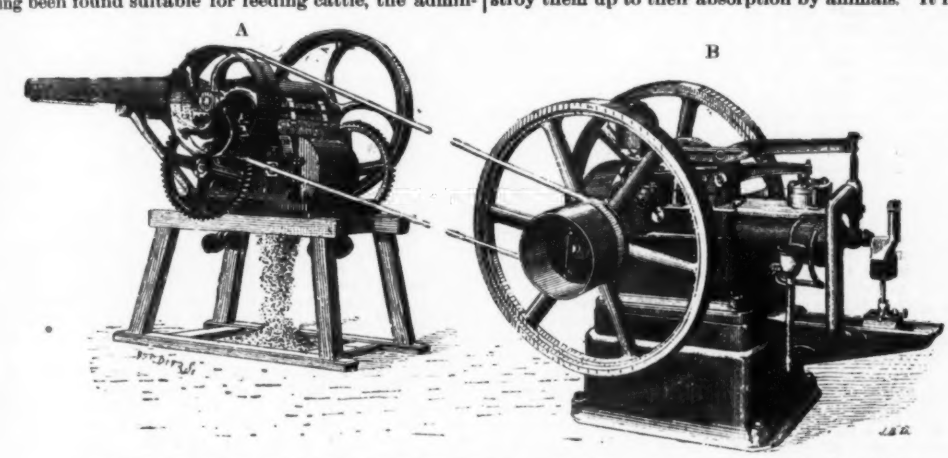
The present machines produce 2,200 pounds of twig fodder per day, representing nearly the same weight of branchlets, less the loss of water. More powerful ones will be installed before long.

After coming from the crushing machine and before being put into bags, the twig fodder is piled up in a corner of the shed, where it is allowed to ferment for two or three days after it has had one per cent. of malt added to it, and has been moistened with vinesse of potatoes, or with bran mixed with warm water. From the beginning of fermentation the temperature of the fodder reaches from 60 to 70 deg., according as the surrounding temperature is itself more or less elevated.

The twig fodder, the mean value of which is comparable to that of second quality hay, is adapted for milch cows, horses, asses, mules, and, in general, to all animals that eat hay. Horses consume it fresh. For oxen it is put in silo for about six months. Like fermentation, ensilage preserves the fodder and communicates to it a savory taste that cattle seem to appreciate.

Mr. J. Japy, president of the agricultural society of Belfort, estimates the product of the fresh twigs of an acre of forest land where wood is cut for fuel (forests of the east) at 33,000 pounds, which would correspond to 22,000 pounds of hay of a value of $320 at the rate of $32 per ton. It is estimated that the price of the twig fodder will be less than that of ordinary fodder in the best years.

From data furnished us by Mr. Kuhn, we have described the mode of treatment to which the twigs are submitted from the moment that they are gathered by those same woodmen who were formerly paid to destroy them up to their absorption by animals. It now remains for us to make known the result of the researches made by Mr. Grandeau to determine, from a chemical standpoint, the nutritive value of the twigs to be triturated. Such value necessarily varies with the different species and the season.



A, MACHINE FOR CRUSHING TWIGS FOR FODDER. B, PETROLEUM MOTOR.

The proportion of nitrogenous matter, the most important element, decreases with extreme rapidity in measure as the diameter of the branchlet increases. The branches of the beech, for example, of from a half to one and a quarter inch in diameter contain less than four per cent. of nitrogenous matter; the branches of from a quarter to half an inch contain about four and a half per cent., and the branchlets of less than a quarter of an inch contain more than ten, that is to say, a proportion equal to that of hay of the best quality. The leaves are the organs most richly provided with nutritive principles, notably with nitrogenous substances.

It will be seen by what precedes that the selection of the twigs cannot be done with too great care.

The following is a table of the average composition of the twig in May and August, based upon the variation in weight and alimentary richness of the three elements that constitute it. This analysis has to do with eighteen different species. Two hundred and twenty pounds of twigs contain:

	In May.	In August.	Difference.
Water	28·6	28·6	
Nitrogenous materials	32·3	26·	+6·3
Oily "	5·5	5·9	−0·4
Cellulose	52·4	50·6	−1·8
Extractive matter	90·7	96·5	+5·8
Mineral "	10·3	12·	+2·3

The permanent commission of the superior council of agriculture has recently advised that the data relative to the use of twig forage be disseminated as widely as possible. If, as there is reason to believe, the hopes that have been founded on the product are realized, science will have once more put a new and important resource at the service of agriculture.—*Le Magasin Pittoresque.*

THE longest canal in the world is the one which extends from the frontier of China to St. Petersburg. It measures in all 4,472 miles. Another canal running from Astrachan to St. Petersburg is 1,434 miles long. Both of these were begun by Peter the Great.

THE NATURE OF DEPOLARIZERS.*

WHEN an electric current is passed between plates of platinum through a solution of sulphuric acid, the hydrogen and oxygen are partly retained at the surfaces—and apparently also within the plates—and under these conditions are capable of interacting, as in the well-known Grove gas battery; so that in so far as the "gases" thus circumstanced are concerned the change may be expressed by a reversible equation. This reversal constitutes the well-known phenomenon termed polarization by physicists.

Reversal owing to the retention of hydrogen in circuit is promoted to different extents by different metals—hence apparently the varying electromotive forces of single fluid cells containing different negative plates; and when the pressure is sufficient to retain the whole of the hydrogen at the plate, it becomes total; hence it is, for example, that zinc does not dissolve in sulphuric acid under great pressure.

Various substances known generally as depolarizers are used to prevent the accumulation of products of electrolysis and the consequent reversal of the action, such as copper sulphate in the case of the Daniell cell and "nitric acid" in the case of the Grove and Bunsen cells; but whereas the action of copper sulphate is easy to understand, that of "nitric acid" offers many difficulties. As the heat of dissolution of copper in dilute sulphuric acid is a negative value (about 12,000 units), the displacement of copper by hydrogen—*i. e.*, the heat of dissolution of hydrogen in copper sulphate—is a positive value, so that not only does the presence of the copper sulphate prevent the accumulation of hydrogen, but in removing hydrogen it also serves to increase the electromotive force of the cell from about 37/46ths to about 50/46ths of a volt. The principle underlying this is extensible even to cases in which one part of the cumulative effect of the cycle of change is a negative value. Thus, although copper has a negative heat of dissolution, it will readily dissolve in dilute sulphuric acid if it be used in place of zinc in a Grove cell, the negative heat of dissolution of copper being more than compensated for by the positive heat of dissolution of hydrogen in "nitric acid;" and it is well known that copper dissolves in many weak acids in presence of oxygen. It is easy to understand how oxygen acts in such cases, but the facts show that the effect produced by "nitric acid" is not so readily interpreted, and their consideration raises important questions of general application.

Russell has shown that when "nitric acid" is freed from nitrous compounds it does not dissolve silver, but that action sets in when a trace of nitric oxide is introduced, and continues with increasing rapidity as the quantity of the nitrous compound—a necessary product of the action—increases; Veley's later experiments have shown that the same is true of copper, without, however, affording any further explanation of the phenomena. Although it is not to be expected that such metals would dissolve in nitric acid even when coupled with a relatively electronegative conductor, as they have negative heats of dissolution, yet if the acid also acted as depolarizer, a cycle might be formed in which sufficient energy would be developed to condition change: it therefore follows that in such cases *nitric acid* does not act as the depolarizer in accordance with the equation: $2Ag + 2NO_3H + ONO_2H = 2AgNO_3 + H_2O + NO_2H$, and that in point of fact the nitrous compound is the depolarizer, although the nitric acid is the actual solvent of the metal, the hydrogen of the acid being virtually directed displaced by the metal with the assistance, however, of the current energy derived from its own oxidation by the nitrous compound.

But what interpretation is to be given of the behavior of more active metals, such as zinc, magnesium, etc., which have positive heats of dissolution, and therefore are capable of dissolving in the pure dilute acid if coupled with a relatively negative conductor? Does nitric acid in their case directly act as a depolarizer? If it be capable of thus acting, such metals even when uncoupled should dissolve in the pure diluted acid. It is noteworthy that when such metals are dissolved in nitric acid, hydrogen is sometimes evolved. It has been suggested that this hydrogen is derived from the interaction of the metal and water, but I cannot now regard this as a probable explanation; its production serves rather to suggest a deficiency of the depolarizing agent, which cannot well occur if nitric acid be the depolarizer. Indeed, if nitric acid be regarded as directly active, it is remarkable that in presence of the large excess of the acid which is always present any hydrogen should escape; and also that the reduction should extend so far as it often does, and not extend merely to the formation of nitrous acid. If, however, the acid be incapable of directly acting as a depolarizer, and a nitrous compound be the initially active depolarizing agent, it is no longer surprising that owing to the nitrous compound suffering further reduction it should be deficient in parts of the circuit, and that consequently hydrogen should escape. Why the reduction should extend so much further when metals having positive heats of dissolution are used, however, still requires elucidation.

In the case of sulphuric acid, whatever metal be dissolved in the *diluted* acid, no reduction takes place; and it is only when the concentrated and more or less heated acid is used that sulphurous oxide and other reduction products are obtained. It appears not improbable that reduction only takes place under conditions under which the presence of sulphuric *oxide* is possible, *i. e.*, that depolarization is effected by sulphuric *oxide* and never by sulphuric *acid*, although this latter may be regarded as the actual solvent of the metal. There is at present no evidence forthcoming to show that nitric acid can dissociate into the anhydride and water, and even if such a change took place in concentrated solutions, there is no reason to assume that it can also take place in dilute solutions, and that this is the explanation of the difference between nitric and sulphuric acids. It is well known, however, that nitric acid is resolved with extreme facility into nitrogen dioxide, water and oxygen, and that it is excessively sensitive to the action of nitric oxide—a trace of nitric oxide would therefore exercise a fermentative action and condition, the formation, it may be, of nitrous acid, or—as there is no evidence compelling us to suppose that the compound represented by the for-

* Reprinted from the Proceedings of the Chemical Society, No. 125.

mula HNO_3 exists—it may be of nitrogen dioxide. In this latter case, solutions of nitric acid would resemble concentrated sulphuric acid in containing a reducible oxide, and it may be that their depolarizing action is initially exerted through such an oxide alone.

To arrive at a clear conception of the function of acids in dissolving metals, and of the nature of depolarizing agents, it would therefore appear to be necessary to take into account many circumstances to which hitherto but little attention has been paid.

HENRY E. ARMSTRONG.

BIOLOGY AND ITS RELATIONS WITH OTHER BRANCHES OF SCIENCE.

By J. S. BURDON-SANDERSON, M.A., M.D., LL.D., D.C.L., F.R.S., F.R.S E., Professor of Physiology in the University of Oxford.*

WE are assembled this evening as representatives of the sciences—men and women who seek to advance knowledge by scientific methods. The common ground on which we stand is that of belief in the paramount value of the end for which we are striving, of its inherent power to make men wiser, happier and better; and our common purpose is to strengthen and encourage one another in our efforts for its attainment. We have come to learn what progress has been made in departments of knowledge which lie outside of our own special scientific interests and occupations, to widen our views and to correct whatever misconceptions may have arisen from the necessity which limits each of us to his own field of study; and, above all, we are here for the purpose of bringing our divided energies into effectual and combined action.

Probably few of the members of the association are fully aware of the influence which it has exercised during the last half century and more in furthering the scientific development of this country. Wide as is the range of its activity, there has been no great question in the field of scientific inquiry which it has failed to discuss; no important line of investigation which it has not promoted; no great discovery which it has not welcomed. After more than sixty years of existence it still finds itself in the energy of middle life, looking back with satisfaction to what it has accomplished in its youth, and forward to an even more efficient future. One of the first of the national associations which exist in different countries for the advancement of science, its influence has been more felt than that of its successors, because it is more wanted. The wealthiest country in the world, which has profited more—vastly more—by science than any other, England stands alone in the discredit of refusing the necessary expenditure for its development, and cares not that other nations should reap the harvest for which her own sons have labored.

It is surely our duty not to rest satisfied with the reflection that England in the past has accomplished so much, but rather to unite and agitate in the confidence of eventual success. It is not the fault of governments, but of the nation, that the claims of science are not recognized. We have against us an overwhelming majority of the community, not merely of the ignorant, but of those who regard themselves as educated, who value science only in so far as it can be turned into money; for we are still in great measure —in greater measure than any other—a nation of shopkeepers. Let us who are of the minority—the remnant who believe that truth is in itself of supreme value, and the knowledge of it of supreme utility—do all that we can to bring public opinion to our side, so that the century which has given Young, Faraday, Lyell, Darwin, Maxwell and Thomson to England may, before it closes, see us prepared to take our part with other countries in combined action for the full development of natural knowledge.

Last year the necessity of an imperial observatory for physical science was, as no doubt many are aware, the subject of a discussion in Section A, which derived its interest from the number of leading physicists who took part in it, and especially from the presence and active participation of the distinguished man who is at the head of the National Physical Laboratory at Berlin. The equally pressing necessity for a central institution for chemistry, on a scale commensurate with the practical importance of that science, has been insisted upon in this association and elsewhere by distinguished chemists. As regards biology I shall have a word to say in the same direction this evening. Of these three requirements it may be that the first is the most pressing. If so, let us all, whatever branch of science we represent, unite our efforts to realize it, in the assurance that if once the claim of science to liberal public support is admitted, the rest will follow.

In selecting a subject on which to address you this evening, I have followed the example of my predecessors in limiting myself to matters more or less connected with my own scientific occupations, believing that in discussing what most interests myself I should have the best chance of interesting you. The circumstance that at the last meeting of the British Association in this town, Section D assumed for the first time the title which it has since held, that of the Section of Biology, suggested to me that I might take the word "biology" as my starting point, giving you some account of its origin and first use, and of the relations which subsist between biology and other branches of natural science.

ORIGIN AND MEANING OF THE TERM "BIOLOGY."

The word "biology," which is now so familiar as comprising the sum of the knowledge which has as yet been acquired concerning living nature, was unknown until after the beginning of the present century. The term was first employed by Treviranus, who proposed to himself as a life task the development of a new science, the aim of which should be to study the forms and phenomena of life, its origin and the conditions and laws of its existence, and embodied what was known on these subjects in a book of seven volumes, which he entitled "Biology, or the Philosophy of Living Nature." For its construction the material was very scanty, and was chiefly derived from the anatomists and physiologists. For botanists were entirely occupied in completing the work which Linnæus had begun, and the scope of zoology was in like manner limited to the description and classification of animals. It was a new thing to regard the study of living nature as a science by itself, worthy to occupy a place by the side of natural philosophy, and it was, therefore, necessary to vindicate its claim to such a position. Treviranus declined to found this claim on its useful applications to the arts of agriculture and medicine, considering that to regard any subject of study in relation to our bodily wants—in other words, to utility—was to narrow it, but dwelt rather on its value as a discipline and on its surpassing interest. He commends biology to his readers as a study which, above all others, "nourishes and maintains the taste for simplicity and nobleness; which affords to the intellect ever new material for reflection, and to the imagination an inexhaustible source of attractive images."

Being himself a mathematician as well as a naturalist, he approaches the subject both from the side of natural philosophy and from that of natural history, and desires to found the new science on the fundamental distinction between living and non-living material. In discussing this distinction, he takes as his point of departure the constancy with which the activities which manifest themselves in the universe are balanced, emphasizing the impossibility of excluding from that balance the vital activities of plants and animals. The difference between vital and physical processes he accordingly finds, not in the nature of the processes themselves, but in their co-ordination; that is, in their adaptedness to a given purpose, and to the peculiar and special relation in which the organism stands to the external world. All of this is expressed in a proposition difficult to translate into English, in which he defines life as consisting in the reaction of the organism to external influences, and contrasts the uniformity of vital reactions with the variety of their exciting causes.*

The purpose which I have in view, in taking you back as I have done to the beginning of the century, is not merely to commemorate the work done by the wonderfully acute writer to whom we owe the first scientific conception of the science of life as a whole, but to show that this conception, as expressed in the definition I have given you as its foundation, can still be accepted as true. It suggests the *idea of organism* as that to which all other biological ideas must relate. It also suggests, although perhaps it does not express it, that *action* is not an attribute of the organism but of its essence—that if, on the other hand, protoplasm is the basis of life, life is the basis of protoplasm. Their relations to each other are reciprocal. We think of the visible structure only in connection with the invisible process. The definition is also of value as indicating at once the two lines of inquiry into which the science has divided by the natural evolution of knowledge. These two lines may be easily educed from the general principle from which Treviranus started, according to which it is the fundamental characteristic of the organism that all that goes on in it is to the advantage of the whole. I need scarcely say that this fundamental conception of organism has at all times presented itself to the minds of those who have sought to understand the distinction between living and non-living. Without going back to the true father and founder of biology, Aristotle, we may recall with interest the language employed in relation to it by the physiologists of three hundred years ago. It was at that time expressed by the term *consensus partium*—which was defined as the concurrence of parts in action, of such a nature that each does *quod suum est*, all combining to bring about one effect "as if they had been in secret council," but at the same time *constanti quadam naturæ lege.* † Prof. Huxley has made familiar to us how a century later Descartes imagined to himself a mechanism to carry out this *consensus*, based on such scanty knowledge as was then available of the structure of the nervous system. The discoveries of the early part of the present century relating to reflex action and the functions of sensory and motor nerves served to realize in a wonderful way his anticipations as to the channels of influence, afferent and efferent, by which the *consensus* is maintained; and in recent times (as we hope to learn from Prof. Horsley's lecture on the physiology of the nervous system) these channels have been investigated with extraordinary minuteness and success.

Whether with the old writers we speak about *consensus*, with Treviranus about *adaptation*, or are content to take *organism* as our point of departure, it means that, regarding a plant or an animal as an organism, we concern ourselves primarily with its activities, or, to use the word which best expresses it, its energies. Now, the first thing that strikes us in beginning to think about the activities of an organism is that they are naturally distinguishable into two kinds, according as we consider the action of the whole organism in its relation to the external world or to other organisms, or the action of the parts or organs in their relation to each other. The distinction to which we are thus led between the *internal* and *external* relations of plants and animals has, of course, always existed, but has only lately come into such prominence that it divides biologists more or less completely into two camps—on the one hand those who make it their aim to investigate the actions of the organism and its parts by the accepted methods of physics and chemistry, carrying this investigation as far as the conditions under which each process manifests itself will permit; on the other, those who interest themselves rather in considering the place which each organism occupies, and the part which it plays in the economy of nature. It is apparent that the two lines of inquiry, although they equally relate to what the organism *does*, rather than to what it *is*, and, therefore, both have equal right to be included in the one great science of life, or biology, yet lead in directions which are scarcely even parallel. So marked, indeed, is the distinction, that Prof. Haeckel some twenty years ago proposed to separate the study of organisms with reference to their place in nature under the designation of "œcology," defining it as comprising "the relations of the animal to its organic as well as to its inorganic environment, particularly its friendly or hostile relations to those animals or plants with which it comes into direct contact."* Whether this term expresses it or not, the distinction is a fundamental one. Whether with the œcologist we regard the organism in relation to the world, or with the physiologist as a wonderful complex of vital energies, the two branches have this in common, that both studies fix their attention, not on stuffed animals, butterflies in cases, or even microscopical sections of the animal or plant body—all of which relate to the framework of life—but on life itself.

The conception of biology which was developed by Treviranus, as far as the knowledge of plants and animals which then existed rendered possible, seems to me still to express the scope of the science. I should have liked, had it been within my power, to present to you both aspects of the subject in equal fullness; but I feel that I shall best profit by the present opportunity if I derive my illustrations chiefly from the division of biology to which I am attached—that which concerns the *internal* relations of the organism, it being my object not to specialize in either direction, but as Treviranus desired to do, to regard it as part—surely a very important part—of the great science of nature.

The origin of life, the first transition from non-living to living, is a riddle which lies outside of our scope. No seriously minded person, however, doubts that organized nature as it now presents itself to us has become what it is by a process of gradual perfecting or advancement, brought about by the elimination of those organisms which failed to obey the fundamental principle of adaptation which Treviranus indicated. Each step, therefore, in this evolution is a reaction to external influences, the motive of which is essentially the same as that by which from moment to moment the organism governs itself. And the whole process is a necessary outcome of the fact that those organisms are most prosperous which look best after their own welfare. As in that part of biology which deals with the internal relations of the organism, the interest of the individual is in like manner the sole motive by which every energy is guided. We may take what Treviranus called *selfish* adaptation—*Zweckmassigkeit fur sich selber*—as a connecting link between the two branches of biological study. Out of this relation springs another which I need not say was not recognized until after the Darwinian epoch—that I mean which subsists between the two evolutions, that of the race and that of the individual. Treviranus, no less distinctly than his great contemporary Lamarck, was well aware that the affinities of plants and animals must be estimated according to their developmental value, and consequently that classification must be founded on development; but it occurred to no one what the real link was between descent and development; nor was it, indeed, until several years after the publication of the "Origin" that Haeckel enunciated that "biogenetic law," according to which the development of any individual organism is but a memory, a recapitulation by the individual of the development of the race—of the process for which Fritz Muller had coined the excellent word "phylogenesis;" and that each stage of the former is but a transitory reappearance of a bygone epoch in its ancestral history. If, therefore, we are right in regarding ontogenesis as dependent on phylogenesis, the origin of the former must correspond with that of the latter; that is, on the power which the race or the organism at every stage of its existence possesses of profiting by every condition or circumstance for its own advancement.

From the short summary of the connection between different parts of our science you will see that biology naturally falls into three divisions, and these are even more sharply distinguished by their methods than by their subjects; namely, *Physiology*, of which the methods are entirely experimental; *Morphology*, the science which deals with the forms and structure of plants and animals, and of which it may be said that the body is anatomy, the soul development; and finally, *Œcology*, which uses all the knowledge it can obtain from the other two, but chiefly rests on the exploration of the endless varied phenomena of animal and plant life as they manifest themselves under natural conditions. This last branch of biology—the science which concerns itself with the external relations of plants and animals to each other, and to the past and present conditions of their existence—is by far the most attractive. In it those qualities of mind which especially distinguish the naturalist find their highest exercise, and it represents more than any other branch of the subject what Treviranus termed the "philosophy of living nature." Notwithstanding the very general interest which several of its problems excite at the present moment, I do not propose to discuss any of them, but rather to limit myself to the humbler task of showing that the fundamental idea which finds one form of expression in the world of living beings regarded as a whole—the prevalence of the best—manifests itself with equal distinctness and plays an equally essential part in the internal relations of the organism in the great science which treats of them—Physiology.

ORIGIN AND SCOPE OF MODERN PHYSIOLOGY.

Just as there was no true philosophy of living nature until Darwin, we may with almost equal truth say that physiology did not exist as a science before Johannes Muller. For although the sum of his numerous achievements in comparative anatomy and physiology, notwithstanding their extraordinary number and importance, could not be compared for merit and fruitfulness with the one discovery which furnished the key to so many riddles, he, no less than Darwin, by his influence on his successors was the beginner of a new era.

Muller taught in Berlin from 1833 to 1857. During that time a gradual change was in progress in the way in which biologists regarded the fundamental problem of life. Muller himself, in common with Treviranus and all the biological teachers of his time, was a vitalist, *i. e.*, he regarded what was then called the *vis vitalis*—the *Lebenskraft*—as something capa-

* Presidential address, British Association, Nottingham, 1893.

* "Leben besteht in der Gleichformigkeit der Reaktionen bei ungleichformigen Einwirkungen der Aussenwelt."—Treviranus, *Biologie oder Philosophie der lebenden Natur*, Gottingen, 1802, vol. i., p. 83.

† Bausner, *De Consensu Partium Humani Corporis*, Amst., 1556, Præf. ad lectorem, p. 4.

* These he identifies with "those complicated mutual relations which Darwin designates as conditions of the struggle for existence." Along with chorology—the distribution of animals—œcology constitutes what he calls *Relations-physiologie*. Haeckel, "Entwickelungsgang u. Aufgaben der Zoologie," *Jenaische Zeitschr.*, vol. v., 1869, p. 353.

ble of being correlated with the physical forces; and as a necessary consequence held that phenomena should be classified or distinguished, according to the forces which produced them, as vital or physical, and that all those processes—that is groups or series of phenomena in living organisms—for which, in the then very imperfect knowledge which existed, no obvious physical explanation could be found, were sufficiently explained when they were stated to be dependent on so-called vital laws. But during the period of Muller's greatest activity times were changing, and he was changing with them. During his long career as professor at Berlin he became more and more objective in his tendencies, and exercised an influence in the same direction on the men of the next generation, teaching them that it was better and more useful to observe than to philosophize; so that, although he himself is truly regarded as the last of the vitalists—for he was a vitalist to the last—his successors were adherents of what has been very inadequately designated the mechanistic view of the phenomena of life. The change thus brought about just before the middle of this century was a revolution. It was not a substitution of one point of view for another, but simply a frank abandonment of theory for fact, of speculation for experiment. Physiologists ceased to theorize because they found something better to do. May I try to give you a sketch of this era of progress?

Great discoveries as to the structure of plants and animals had been made in the course of the previous decade, those especially which had resulted from the introduction of the microscope as an instrument of research. By its aid Schwann had been able to show that all organized structures are built up of those particles of living substance which we now call cells, and recognize as the seats and sources of every kind of vital activity. Hugo Mohl, working in another direction, had given the name "protoplasm" to a certain hyaline substance which forms the lining of the cells of plants, though no one as yet knew that it was the essential constituent of all living structures—the basis of life no less in animals than in plants. And, finally, a new branch of study—histology—founded on observations which the microscope had for the first time rendered possible, had come into existence. Bowman, one of the earliest and most successful cultivators of this new science, called it physiological anatomy,* and justified the title by the very important inferences as to the secreting function of epithelial cells and as to the nature of muscular contraction, which he deduced from his admirable anatomical researches. From structure to function, from microscopical observation to physiological experiment, the transition was natural. Anatomy was able to answer some questions, but asked many more. Fifty years ago physiologists had microscopes, but had no laboratories. English physiologists—Bowman, Paget, Sharpey—were at the same time anatomists, and in Berlin, Johannes Muller, along with anatomy and physiology, taught comparative anatomy and pathology. But soon that specialization which, however much we may regret its necessity, is an essential concomitant of progress, became more and more inevitable. The structural conditions on which the processes of life depend had become, if not known, at least accessible to investigation; but very little indeed had been ascertained of the nature of the processes themselves—so little, indeed, that if at this moment we could blot from the records of physiology the whole of the information which had been acquired say in 1840, the loss would be difficult to trace—not that the previously known facts were of little value, but because every fact of moment has since been subjected to experimental verification. It is for this reason that, without any hesitation, we accord to Muller and to his successors, Brucke, Du Bois-Reymond, Helmholtz, who were his pupils, and Ludwig, in Germany, and to Claude Bernard† in France, the title of founders of our science. For it is the work which they began at that remarkable time (1845–1855), and which is now being carried on by their pupils or their pupils' pupils in England, America, France, Germany, Denmark, Sweden, Italy, and even in that youngest contributor to the advancement of science, Japan, that physiology has been gradually built up to whatever completeness it has at present attained.

What were the conditions which brought about this great advance which coincided with the middle of the century? There is but little difficulty in answering the question. I have already said that the change was not one of doctrine, but of method. There was, however, a leading idea in the minds of those who were chiefly concerned in bringing it about. That leading notion was that, however complicated may be the conditions under which vital energies manifest themselves, they can be split into processes which are identical in nature with those of the non-living world, and, as a corollary to this, that the analyzing of a vital process into its physical and chemical constituents, so as to bring these constituents into measurable relation with physical or chemical standards, is the only mode of investigating them which can lead to satisfactory results.

There were several circumstances which at that time tended to make the younger physiologists (and all of the men to whom I have just referred were then young) sanguine, perhaps too sanguine, in the hope that the application of experimental methods derived from the exact sciences would afford solutions of many physiological problems. One of these was the progress which had been made in the science of chemistry, and particularly the discovery that many of the compounds which before had been regarded as special products of vital processes could be produced in the laboratory, and the more complete knowledge which had been thereby acquired of their chemical constitutions and relations. In like manner, the new school profited by the advances which had been made in physics, partly by borrowing from the physical laboratory various improved methods of observing the phenomena of living beings, but chiefly in consequence of the direct bearing of the crowning discovery of that epoch (that of the conservation of energy) on the discussions which then took place as to the relations between vital and physical forces; in connection with which it may be noted that two of those who (along with Mr. Joule and your president at the last Nottingham meeting) took a prominent part in that discovery—Helmholtz and J. R. Mayer—were physiologists as much as they were physicists. I will not attempt even to enumerate the achievements of that epoch of progress. I may, however, without risk of wearying you, indicate the lines along which research at first proceeded, and draw your attention to the contrast between then and now. At present a young observer who is zealous to engage in research finds himself provided with the most elaborate means of investigation, the chief obstacle to his success being that the problems which have been left over by his predecessors are of extreme difficulty, all of the easier questions having been worked out. There were then also difficulties, but of an entirely different kind. The work to be done was in itself easier, but the means for doing it were wanting, and every investigator had to depend on his own resources. Consequently, the successful men were those who, in addition to scientific training, possessed the ingenuity to devise and the skill to carry out methods for themselves. The work by which Du Bois-Reymond laid the foundation of animal electricity would not have been possible had not its author, besides being a trained physicist, known how to do as good work in a small room in the upper floor of the old University building at Berlin as any which is now done in his splendid laboratory. Had Ludwig not possessed mechanical aptitude, in addition to scientific knowledge, he would have been unable to devise the apparatus by which he measured and recorded the variations of arterial pressure (1848), and verified the principles which Young had laid down thirty years before as to the mechanics of the circulation. Nor, lastly, could Helmholtz, had he not been a great deal more than a mere physiologist, have made those measurements of the time relations of muscular and nervous responses to stimulation, which not only afford a solid foundation for all that has been done since in the same direction, but have served as models of physiological experiment, and as evidence that perfect work was possible and was done by capable men, even when there were no physiological laboratories.

Each of these examples relates to work done within a year or two of the middle of the century.* If it were possible to enter more fully on the scientific history of the time, we should, I think, find the clearest evidence, first, that the foundation was laid in anatomical discoveries, in which it is gratifying to remember that English anatomists (Allen Thomson, Bowman, Goodsir, Sharpey) took considerable share; secondly, that progress was rendered possible by the rapid advances which, during the previous decade, had been made in physics and chemistry, and the participation of physiology in the general awakening of the scientific spirit which these discoveries produced. I venture, however, to think that, notwithstanding the operation of these two causes, or rather combinations of causes, the development of our science would have been delayed had it not been for the exceptional endowments of the four or five young experimenters whose names I have mentioned, each of whom was capable of becoming a master in his own branch, and of guiding the future progress of inquiry.

Just as the affinities of an organism can be best learned from its development, so the scope of a science may be most easily judged of by the tendencies which it exhibits in its origin. I wish now to complete the sketch I have endeavored to give of the way in which physiology entered on the career it has since followed for the last half century, by a few words as to the influence exercised on general physiological theory by the progress of research. We have seen that no real advance was made until it became possible to investigate the phenomena of life by methods which approached more or less closely to those of the physicist, in exactitude. The methods of investigation being physical or chemical, the organism itself naturally came to be considered as a complex of such processes, and nothing more. And in particular the idea of adaptation, which, as I have endeavored to show, is not a consequence of organism, but its essence, was in great measure lost sight of. Not, I think, because it was any more possible than before to conceive of the organism otherwise than as a working together of parts for the good of the whole, but rather that, if I may so express it, the minds of men were so occupied with new facts that they had not time to elaborate theories. The old meaning of the term "adaptation" as the equivalent of "design" had been abandoned, and no new meaning had yet been given to it, and consequently the word "mechanism" came to be employed as the equivalent of "process," as if the constant concomitance or sequence of two events was in itself a sufficient reason for assuming a mechanical relation between them. As in daily life so also in science, the misuse of words leads to misconceptions. To assert that the link between *a* and *b* is mechanical, for no better reason than that *b* always follows *a*, is an error of statement, which is apt to lead the incautious reader or hearer to imagine that the relation between *a* and *b* is understood, when in fact its nature may be wholly unknown. Whether or not at the time which we are considering some physiological writers showed a tendency to commit this error, I do not think that it found expression in any generally accepted theory of life. It may, however, be admitted that the rapid progress of experimental investigation led to too confident anticipations, and that to some enthusiastic minds it appeared as if we were approaching within measurable distance of the end of knowledge. Such a tendency is, I think, a natural result of every signal advance. In an eloquent Harveian oration, delivered last autumn by Dr. Bridges, it was indicated how, after Harvey's great discovery of the circulation, men were too apt to found upon it explanations of all phenomena, whether of health or disease, to such an extent that the practice of medicine was even prejudicially affected by it. In respect of its scientific importance the epoch we are considering may well be compared with that of Harvey, and may have been followed by an undue preference of the new as compared with the old, but no more permanent unfavorable results have shown themselves. As regards the science of medicine, we need only remember that it was during the years between 1845 and 1860 that Virchow made those researches by which he brought the processes of disease into immediate relation with the normal processes of cell development and growth, and so, by making pathology a part of physiology, secured its subsequent progress and its influence on practical medicine. Similarly in physiology, the achievements of those years led on without any interruption or drawback to those of the following generation; while in general biology, the revolution in the mode of regarding the internal processes of the animal or plant organism which resulted from these achievements prepared the way for the acceptance of the still greater revolution which the Darwinian epoch brought about in the views entertained by naturalists of the relations of plants and animals to each other and to their surroundings.

It has been said that every science of observation begins by going out botanizing, by which, I suppose, is meant that collecting and recording observations is the first thing to be done in entering on a new field of inquiry. The remark would scarcely be true of physiology, even at the earliest stage of its development, for the most elementary of its facts could scarcely be picked up as one gathers flowers in a wood. Each of the processes which go to make up the complex of life requires separate investigation, and in each case the investigation must consist in first splitting up the process into its constituent phenomena, and then determining their relation to each other, to the process of which they form part, and to the conditions under which they manifest themselves. It will, I think, be found that even in the simplest inquiry into the nature of vital processes some such order as this is followed. Thus, for example, if muscular contraction be the subject on which which we seek information, it is obvious that, in order to measure its duration, the mechanical work it accomplishes, the heat wasted in doing it, the electromotive forces which it develops, and the changes of form associated with these phenomena, special modes of observation must be used for each of them, that each measurement must be in the first instance separately made, under special conditions, and by methods specially adapted to the required purpose. In the synthetic part of the inquiry the guidance of experiment must again be sought for the purpose of discriminating between apparent and real causes, and of determining the order in which the phenomena occur. Even the simplest experimental investigations of vital processes are beset with difficulties. For in addition to the extreme complexity of the phenomena to be examined and the uncertainties which arise from the relative inconstancy of the conditions of all that goes on in the living organism, there is this additional drawback, that, whereas in the exact sciences experiment is guided by well ascertained laws, here the only principle of universal application is that of adaptation, and that even this cannot, like a law of physics, be taken as a basis for deductions, but only as a summary expression of that relation between external exciting causes and the reactions to which they give rise, which, in accordance with Treviranus' definition, is the essential character of vital activity.

(To be continued.)

STRANGE FREAKS OF MEMORY.

So many and varied are the phases which those strange maladies, aphasia and loss of memory, may assume, that the following instances of their vagaries, given by a writer in the *New York Herald*, form a very entertaining study:

The remarkable occurrence recently reported from Australia, where a man entered a Melbourne police station and asked the officers to assist him in establishing his identity, as he could neither remember his name nor any incident of the past further back than the previous day, lends a renewed interest to the subject of those mysterious mental phenomena, aphasia and loss of memory. Aphasia is now a term of very wide meaning, and usually manifests itself by partial or entire privation of voice, coupled with forgetfulness or distortion of language, events, persons, places and things. Loss of memory is just what its name implies. Aphasia is produced by an abnormal cerebral condition. In its initial phases patients forget certain words; in the worst cases they lose all power of expression and are unable to originate or understand anything. Ordinarily, however, aphasics, as they are called, preserve a look of intelligence, are competent to engage in games of skill and give general evidence of sanity. In short, outside of their frequently total inability to speak or write, they evidence no change from the normal condition. During the world-famous Tichborne trial in England some twenty years ago the supposed strange forgetfulness displayed by the "Claimant" of certain foreign tongues in which the missing heir to the Tichborne title and estates was known to have been proficient was sought to be accounted for by his counsel and witnesses on the ground that some species of aphasia might possibly have affected his memory. A French lawyer of considerable note was troubled with complete forgetfulness of the commonest everyday phrases; he could not ask for his hat, but when he required it would point to his head; and so with his umbrella, his gloves, and other personal articles. It was diagnosed as a case of partial aphasia.

An old English country gentleman who had a number of servants utterly failed to retain any recollection of the names of any one of them, though many were old retainers and he formerly had their names at the tip of his tongue. Two of his men servants he distinguished by the whimsical titles of "Old Water" and "Young Water," and his doctor, of whose name he was equally oblivious, he rechristened "Young Knockemdown." Certain persons of rank in the vicinity he distinguished as "the King," "the Queen," "the Grand Vizier," their proper appellation being absolutely forgotten by him. If he wished to indicate others of his acquaintance he managed to do so by simply mimicking some of their personal peculiarities. To ascertain the date he would take a calendar, place it in his physician's hand and say, "What's o'clock?"

* The first part of the *Physiological Anatomy* appeared in 1843. It was concluded in 1856.

† It is worthy of note that these five distinguished men were nearly contemporaries: Ludwig graduated in 1839, Bernard in 1843, the other three between those dates. Three survive—Helmholtz, Ludwig, Du Bois-Reymond.

* The "Untersuchungen uber thierische Electricitat" appeared in 1848; Ludwig's researches on the circulation, which included the first description of the "kymograph," and served as the foundation of the "graphic method," in 1847; Helmholtz's research on the propagation in motor nerves in 1851.

meaning the day of the month. A new bridge was completed near his residence and the old gentleman wanted to visit it; so he directed his coachman to drive him to "where he had never been before," which indefinite direction was correctly interpreted to mean the new bridge. This old man had been noted as a linguist, and his aphasic affection took this peculiar form, a not uncommon manifestation of the disease.

We may now consider the interesting psychological question, Does the destruction of the vocal power affect other parts of the mental fabric? The settling of this point has always been a very difficult question with the medical profession, because the very nature of aphasia debars patients from submitting to the regular tests that doctors apply in cases of suspected insanity. Eminent physicians have differed on the point, as I will now show. Dr. Trosseau, of France, who originated the medical term "aphasia," says that in this disease the mind is injured, as the faculty of memory is impaired, and he reaches this conclusion largely from his experience with cases where he applied tests of his own, consisting of the showing of certain objects to patients and asking them fanciful names for each. In every case the patient would shake his head, but when the doctor mentioned the true name he received a sign of assent. Another debated question as to aphasia is whether language should be regarded as an outlet for thought or as an indispensable part of thought.

Psychologists claim that thought and language are one, and yet we see that aphasia does not cause the loss of ideas. Persons recovered from aphasia have, unfortunately for science, said little upon the point as to whether thought can be carried on without words, though they have said a good deal as to the rest of their experiences while ill. In 1772 Dr. Spalding, a well-known Berlin physician, was sitting in his study writing out a receipt for money, and after writing two words, sudden as a lightning flash he lost all sense of their meaning. He tried to write on, but the sense of the words he had intended to write and that of all other words had deserted him, so at last in despair he threw down the pen and tried to speak, but found he could utter only monosyllables. On recovering, which he did soon after, Dr. Spalding says that he carried on the thinking process, but he has neglected to tell us whether he thought in words which he could not speak or write.

A French physician sat in his room reading Lamartine, when suddenly the meaning of the words on the printed page completely left his mind. Much alarmed, he tried to call for help, but discovered that he was tonguetied, whereupon, fearing paralysis, he began to exercise his limbs, and found them all right. Next he tried to write, but his power to do so was gone. Meantime he was using all his professional knowledge in an effort to reason out the possible cause of the calamity, and when a doctor was summoned he made signs that he wished to be bled. No sooner was this done than he recovered, but in leaving a record of his experience he fails to say how he thought—with or without words.

TYPHOID FEVER IN HARTFORD IN 1891 AND 1892.

The last *Report of the State Board of Health of Connecticut* contains a paper on Connecticut River Water as a Source of Typhoid Fever at Hartford, contributed by Dr. Herbert E. Smith, the board's chemist.

The water supply of Hartford is ordinarily ample under a gravity system, feeding a suitable number of storage reservoirs. During a period of seven years, ending in 1891, it was at no time necessary to resort to river water, and the pumps at the river stations have been maintained only for emergencies. In 1891, however, the storage supply ran so low that a part of the city was supplied from the river, notwithstanding the fact that it was known that the river was constantly subject to contamination by sewage from Springfield, Mass., and from other smaller towns north of Hartford.

In the spring of 1892 there was an unusual number of cases of fever, and Dr. Smith was requested to make an investigation in order to learn how far the water supply or other possible sources of the disease had been at fault. The condition of the river water, it may be said, had been a source of more or less apprehension on the part of the consumers. This river water supply, therefore, was properly made the chief subject of inquiry, but attention was also given to the milk supply and the ice supply. These latter were severally excluded as the inquiry progressed, and the river water as a public supply to a part of the city became more and more distinctly incriminated.

The district supplied by river water, being populous and otherwise specially susceptible, had been in previous years more severely visited by fever than other districts. This peculiarity was present, also, to an exaggerated extent in 1892, but the greatest significance was attached to the prevalence of the fever in unusual months and to the fact that those months corresponded with the period of the river supply *plus* an average incubation period. Thus there were more cases of fever during the unusual months, November, December, and January—a period corresponding to the time when cases originating in the use of the suspected supply must have appeared. The reporter rejects the argument as to an epidemic influence possibly existing at that time, on the score that the fever was manifest nowhere else in the State than in Hartford.

The months of November and December, 1892, were marked by a high typhoid fever mortality—the reported or estimated number of cases not being given for comparison—due to a return to the use of river water during three weeks and a half ending November 18, 1892. This recurrence of fever must be taken as confirmatory of the position assumed in respect to the unusual prevalence of typhoid fever a year before—namely, that the water from the river was a large factor, probably the largest one—along with other factors never wholly absent, in fanning the fever flame in winter.

The reporter takes up the question: Why, if the river water was productive of so many fever cases, were there not even more cases? His reply is important. He states that the sanitary officers of Hartford early and strongly urged the people of the river district to boil the water used for domestic purposes. This advice was very generally followed, it is believed. Furthermore, the river was not grossly polluted at the time of its examination by Dr. Smith, and was probably not very much worse at the times when it was used as a public source of supply. A large amount of sewage, no doubt, flows into the stream, but the dilution is so very great that the chemical constitution of the water as a whole is not decidedly affected. Although in the latter part of 1891 the contamination was relatively much greater than usual, on account of the low state of the river, still it is not clear that the water contained large amounts of typhoid fever poison. Our best observers hold the opinion that under conditions such as ruled at Hartford a large proportion of the endangered population will resist the contamination, and that only the more susceptible part will contract the fever.

The source of the typhoid fever germs was not positively discovered, but the opinion of the reporter is that they came down the river from Springfield, twenty-five miles distant from the point where the Hartford supply is taken in. Cases and deaths had occurred at Springfield in the latter part of 1891, and it cannot be doubted that fever germs entered the river and were carried southward. But the investigation was proposed to Dr. Smith at a period when it was too late for him to satisfy himself that the germs of typhoid fever were water-borne over that extent of twenty-five miles in number and virulence adequate to cause the transplantation of the disease from the one city to the other. It is Dr. Smith's belief that this was the manner of causation of the winter cases at Hartford in the river-supplied district.

Dr. Smith feels warranted by his facts in asserting that the Connecticut River just above Hartford is as pure as at any other point in his State, and he remarks that it is unsafe to use its water for drinking at any point in that State. That city is the only one that has hitherto resorted to river water as a public supply, even in emergencies, and the lesson taught by the experiences of the past two years will doubtless prevent the repetition of the experiment at any point within the reach of the influence of the State Board of Health, of which Dr. Smith is a member.—*N. Y. Med. Jour.*

A MUTE WHO IS CAPABLE OF SPEAKING.

As well known, mutes exchange their thoughts by signs, each corresponding to a letter of the alphabet,

APPARATUS FOR REPLACING A LOST LARYNX.

by gestures, by a mimicry that brings into play the muscles of the face, and even by more or less guttural sounds that translate their agreeable sensations or their painful impressions. All this, doubtless, constitutes an expressive language, but not a language in the true sense of the word, that is to say, a spoken language. It would seem *a priori* that when a mute speaks he ceases to be a mute by the very fact that he modulates his sounds; but such is not always the case. At one of the recent sessions of the Academy of Medicine, Dr. Perier, surgeon of the Lariboisiere Hospital, presented for the examination of his colleagues a mute who expressed all his ideas by speech, that is to say, by modulated sounds. The history of this man is most curious and interesting from a scientific point of view. He was habitually enjoying robust health when he was stricken with an incurable affection of the larynx, the first symptoms of which were observed in January, 1891. Tired of the treatment that he had to undergo for two years, he expressed a desire to be operated upon as radically as possible.

Fortified with such authorization, Dr. Perier proceeded on the 12th of last June to operate upon him for the total extirpation of the larynx. Every one knows that the region of the larynx contains the very organ of the voice, and that the vocal apparatus of man, if it is indisputably the most delicate, is the most perfect of that of the higher beings. Its destruction through disease or accident is consequently followed by aphony.

The operation once terminated according to the rules of art, the skillful surgeon formed in the anterior wall of the neck a small orifice which he left open.

This opening, consequently communicating with both the exterior and the pharynx, was reserved for experiments upon the re-establishment of the voice by means of an artificial larynx. Convalescence proceeded quickly, and on the 28th of June the health of the patient was sufficiently re-established to permit of such experiments.

In concert with Mr. Aubry, the well known manufacturer of surgical instruments, Dr. Perier directed these tentatives (for several technical reasons too long to set forth here) toward the adaptation of an artificial larynx actuated by a blowing device, and not by the air issuing from the trachea.

The apparatus, relatively simple, that they decided to adopt consists of a metallic reed inclosed in a tube, and the plates of which, arranged in contrary directions, obliterate half of the light at each extremity. This tube terminates above in a spherical surface capable of being applied hermetically to the orifice in the front of the neck. Below, it is connected with two elastic reservoirs, coupled and mounted upon a metallic S-shaped armature permitting of one communicating with the other in order to obtain a continuous current of air of mean intensity.

One of the reservoirs is put in communication with a blowing device formed of a bulb similar to those that actuate vaporizers. Under the effect of the current of air, the metallic reed enters into vibration and emits a constant note of uniform tonality, which is approximately that of the ordinary diapason. The sound thus produced is led, so to speak, into the buccal cavity.

It remains then, in order to convert it into true spoken language, only to make it undergo, through the intermedium of the tongue, lips and teeth, as in ordinary phonation, the series of modulations that produce the nuances and the difference in the pronunciation of words.

These nuances, as incredible as the fact may seem at first sight, are, it appears, obtained quite easily. An education of a few days suffices.

The individual who was the object of the communication made to the Paris Academy of Medicine was able, amid the plaudits of the whole assemblage, after receiving his operator with emotion, to retrace the history and detailed phases of his painful disease with a voice that was distinct, although of a low and monotonous tone.—*Le Magasin Pittoresque.*

THE ADVANTAGES OF A SCIENTIFIC EDUCATION.*

By Francis A. Walker, LL.D.

I present the heartiest congratulations of the Massachusetts Institute of Technology to the officers and teachers of McGill University, and especially to Dr. Bovey, on the fortunate completion and the present auspicious dedication to their destined uses of these commodious and superbly equipped laboratories of physics and engineering. The distinguished position which this university has long held in science and the applications of science to useful arts cannot fail to be greatly advanced as the result of these noble benefactions of Mr. McDonald.

The growth of scientific and technical schools on this continent during the past thirty years has savored of the marvelous. In part, it has been due to the changed ideas and the transfigured ideals of the American people; in part, to the recognized need of greater skill and more of scientific knowledge for the development of the natural resources of the continent and for the direction of its growing enterprises. In this movement of the age, even the older institutions have been compelled profoundly to modify their traditional courses of study, substituting scientific and even technical instruction for much that was formerly deemed essential to a liberal education.

Of the reluctance, and even resistance, which this movement has encountered from many who deservedly held high places in the old educational order, I would not speak with harshness. The notion that scientific work was something essentially less fine and high and noble than the pursuit of rhetoric and philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago. And it has not even yet wholly yielded to the demonstration offered by the admirable effects of the new education in training young men to be as modest and earnest, as sincere, manly, and pure, as broad and appreciative, as were the best products of the classical culture, and withal, more exact and resolute and strong. We can hardly hope to see that inveterate prepossession altogether disappear from the minds of those who have entertained it. Probably these good men will have to be buried with more or less of their prejudices still wrapped about them; but from the new generation scientific and technical studies will encounter no such obstruction, will suffer no such disparagement.

Another objection which the new education has encountered is entitled to far more of consideration. This has arisen from the sincere conviction of many distinguished and earnest educators that the pursuit of science, especially where its technical applications are brought strongly out, loses much of that disinterestedness which they claim, and rightly claim, is of the very essence of education. For the spirit of this objection I entertain profound respect. I only differ from these honorable gentlemen in believing that the contemplated uses of science, whether in advancing the condition of mankind or even in promoting the ulterior usefulness, success, and pecuniary profit of the student of a technical profession, do not necessarily impair that disinterestedness which I fully concede is essential to the highest and truest education of the man. These gentlemen appear to me to have an altogether unnecessary fear of the usefulness of science. They entertain much of that dread of "Fruit," which Macaulay, in his famous essay on Bacon, doubtless with something of exaggeration, as his custom was, attributed to the old philosophers.

I am willing to admit that, in my humble judgment,

* Remarks on the dedication of the new science and engineering buildings of McGill University, Montreal, February 24, 1893.—*Tech. Quarterly.*

many technical schools have erred in addressing themselves too closely to the practical side of instruction; that they have in some degree neglected principles in the study of science, and have borne an undue weight upon mere knacks and labor-saving devices and technical methods. I believe that in doing this they have made a mistake, even from their own point of view, and with reference to the very objects they profess. Moreover, I am free to acknowledge that those who direct many technical schools have made a mistake, in altogether, or nearly so, omitting from their curriculum philosophical as distinguished from scientific, liberal as distinguished from exact, studies. Those technical schools will best accomplish their purposes of usefulness, alike to their students and to the State, which make more of the sciences than of the arts, more of principles than of their applications, and which offer to their pupils, in addition to the studies which will make them exact and strong, some of the studies and exercises which will help to render them, at the same time, broad and fine.

With only such a subordination of technical and scientific studies as is for the ultimate advantage of the technical professions themselves, and with such a complementing of scientific by philosophical studies as has been indicated, I believe that the work of the student in schools of technology is as fully entitled to be termed disinterested as that of a student in a classical college. In neither class of institutions can or ought the student to be unmindful that his personal success in life and his professional and social position are largely to depend upon the manner in which his work shall be done in college. All that can be asked in regard to any school is that there shall be zeal in study, delight in discovery, fidelity to the truth as it is discerned, high aims, and ambitions which have not sole or primary respect to material rewards. The strong desire to become a useful man, well equipped for life, capable of doing good work, respected and entitled to respect, constitutes no breach of disinterestedness, in any sense of that word in which an educator would be justified in using it with commendation.

The practical uselessness for any immediate purpose of a given subject of study may be no reason why it should not be pursued; but, on the other hand, the high immediate usefulness of a subject of study furnishes no ground from which the educator of loftiest aims and purest ideals should regard it with contempt or distrust. In either case, the question of real import is in what spirit the study is pursued. The most distinguished French writer of to-day on matters of education, writing, too, in advocacy not of physical but of social science, has frankly paid his tribute to the disinterestedness of spirit and loftiness of motive which promote and direct scientific research, even in its most practical applications. "Let us," he says, "pass in review the great founders of modern science and the creators of industry, the Keplers and the Fultons, and we shall be struck by the idealistic and even Utopian tendency peculiar to them. They are, in their own way, dreamers, artists, poets, controlled by experience."

And if, leaving abstract reasoning, we turn to contemplate the manner in which the several professions are practiced in the community, I seem to find corroboration of the view that the study of science and its applications to the arts of life do not tend to produce sordid character or to confine the man merely to material aims. Every profession has its black sheep and its doubtful practitioners; but, while frankly admitting that there are mercenary physicists and chemists for revenue only, I boldly challenge comparison between the scientific men of America, as a body, and its literary men or even its artists, in the respects of devotion to truth, of simple confidence in the right, of delight in good work for good work's sake, of indisposition to coin name and fame into money, of unwillingness to use one thing that is well done as a means of passing off upon the public three or four things that are ill done. I know the scientific men of America well, and I entertain a profound conviction that in sincerity, simplicity, fidelity, and generosity of character, in nobility of aims and earnestness of effort, in everything which should be involved in the conception of disinterestedness, they are surpassed, if indeed they are approached, by no other body of men.

Let us, then, cheer on every enterprise for the extension of scientific and technical education, without any misgivings as to its effects upon the character and subsequent life of the young men of America, without any fear that they will be rendered sordid in spirit or low in their aims by reason of the practical usefulness of the studies to which they are called to apply themselves. There is a wonderful virtue in the exact sciences to make their students loyal, just-minded, clear-headed, and strong against temptation. Here, no insidious tendencies to mere plausibility, to sophistry, and to self-delusion beset the young and the ambitious. The only success here is to be right. The only failure possible is to be wrong. To be brilliant in error here is only to make the fact of error more conspicuous and more ludicrous. Nothing but the truth, nothing less than the whole truth, this is the dominating spirit of the laboratory, which never withdraws its control over the student to keep him from the false path, which never intermits its inspiration as it urges him onward to the light.

THE TRANSPARENCY OF EBONITE TO LIGHT AND HEAT.

Signor Riccardo Arno has communicated to the Turin Academy of Sciences certain results obtained by him in the course of an investigation on the action of heat rays of various lengths upon thin plates of ebonite. He used six different sources of light, the radiations from which were sent through plates of ebonite of thicknesses varying from 0·12 to 0·52 millimeter. The thinnest plates absorbed 25 per cent. of the heat radiated from an incandescent lamp, the luminous heat rays of which were cut off by a thick plate of glass. When the source of light was very bright, this ebonite film was found to transmit a small portion of the visible red rays. The thinnest film absorbed 69 per cent. of the dark rays from the smoked surface of a Leslie cube containing boiling water, while the thicker plates absorbed 88 per cent. of them; thus showing that ebonite is less transparent for dark rays of heat of low refrangibility than for those more nearly approaching the visible spectrum. The greatest transparency was shown in respect of the dark heat rays on the border of the luminous spectrum. The successive substitution of a hot iron plate, a glowing platinum wire, a Locatellis (gas) lamp, and an incandescent electric lamp for the Leslie cube, was followed by a steady increase of transmitting power in all the specimens of ebonite. These observations may be studied in connection with Tesla's experiments with high frequency phenomena, which go to indicate that the transparency of media is largely a question of conditions.

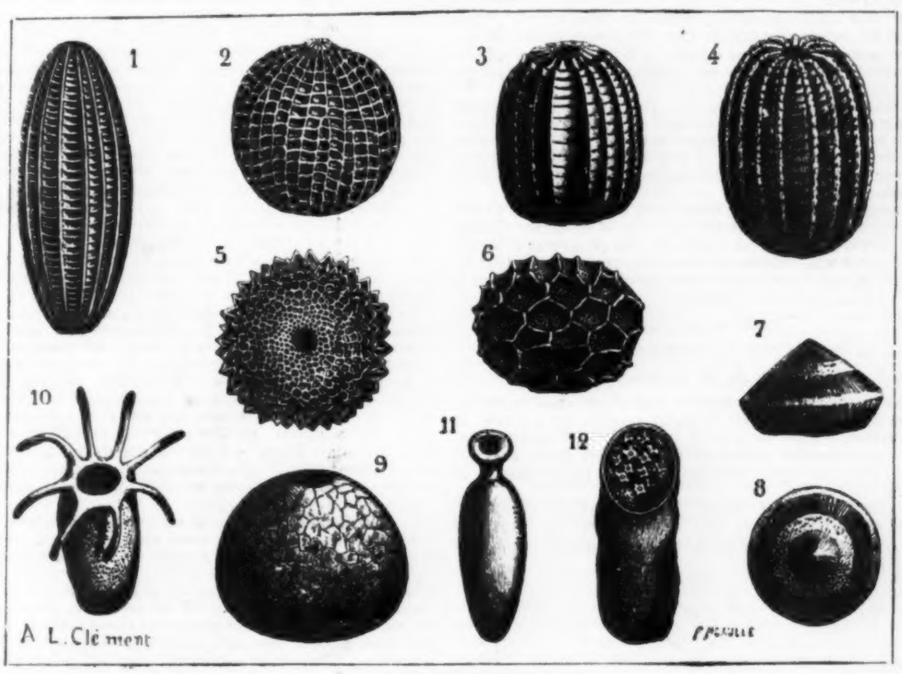
THE EGGS OF INSECTS.

Swammerdam, a Dutch scientist, who was the first to examine insects under the microscope, and whose researches were published in 1737, through the care of the illustrious Boerhaave, has given some curious details as to the eggs of insects.

"Some are oblong," says he, "while others are ovoid or round. There are angular, pyramidal, striate and granular ones. There is no less variety as regards colors; we find white, yellow, red, blue and green ones, and others variegated with colors so singularly combined that it is almost impossible to describe them exactly.

"As for consistence, some are soft and others hard. There are some that are membranous, and others that are covered with a crust similar to parchment or to the shell of a hen's egg. Finally, certain of them are covered with a sort of froth, while others are covered with hairs."

Swammerdam has described with much detail the eggs of the *Nepea cinerea*, a small fresh water hemipter, which he calls the "water scorpion" (Fig. 10). They are of a yellow color, and nearly of the same form as the seed of the holy thistle, slightly elongated and rounded at the lower extremity. They are provided at the upper part with seven slender branches



INSECTS' EGGS.

1 and 2, eggs of the large and small cabbage butterfly; 3, egg of *Papillo hyperantus;* 4, egg of *Vanessa atalanta;* 5 and 6, eggs of *Polyommates;* 7 and 8, egg of *Dicranura vinula* (front and side view); 9, egg of *Pygæra tucephala;* 10, egg of *Nepea cinerea;* 11, egg of gnat; 12, nit of louse.

or stiff bristles, the point of which is red and the center whitish.

These appendages, arranged circularly upon the circumference of each egg, form a sort of open-work egg-cup, which receives in its cavity the end of the following egg, so that the appendages of the first egg embrace the lower extremity of the second, those of the second embrace the third, and so on throughout the entire length of the oviduct.

The eggs of the lepidopters have much analogy with the seeds of plants (Figs. 1, 2, 3 and 4). Those of the small and large cabbage moth have the form of a pyramid, whose base is fastened to a leaf, and the height of which is three or four times greater than the diameter of its base. The eggs are ordinarily formed of eight rounded ribs separated by as many grooves, which extend from the summit to the base. Upon each of these ribs is observed an infinite number of grooves parallel with the base. Those of the large tortoise butterfly are spherical. They are smaller in diameter at the base, or part by which they adhere to the plant, than at the summit, where there are eight equally spaced ridges that descend along the body of the egg, where they form ribs that diminish insensibly in height and disappear before reaching the extremity.

These eggs bear quite a resemblance to those of a nocturnal lepidopter, which Swammerdam does not designate by its specific name, and which attaches its eggs in circular rows to branches of trees, to which they adhere so firmly that they leave an imprint upon the bark and even interfere with the nutrition of the branch to which they are glued. These eggs are also remarkable in that they have the form of those stones that are cut for the construction of vaults, and which are wider at the summit than at the base, so that in accurately joining they arrange themselves in an arch.

Other lepidopters have eggs of a very elegant form. They resemble a sort of small knot channeled and surrounded by a small circular band of purple color.

The eggs of the dragon flies are elongated, and at their extremity are observed little ornaments resembling those of the nit of the louse.

The eggs of the gnat resemble a skittle, the large end of which is rounded and the other extremity terminates in a short neck, like certain liquor flasks (Fig. 11).

The eggs of the ephemeræ are almost imperceptible. They can be seen only under the microscope, and it is also necessary to place them upon black or blue paper. They are plano-convex and oblong in form. The membrane that envelops them appears as if nebulous under the microscope. They are white, as is also the internal tunic of their shell.

If the eggs of the ephemeræ are minute, those of the *Euryantes horribilis*, a New Guinea orthopter, are, on the contrary, as large, it is said, as the eggs of the humming bird.

The privy fly has an oblong, angular egg with lozenge-shaped compartments that form a sort of network. They are very white, and are composed of two distinct envelopes, the external one of which is a true shell like that of a hen's egg, and which breaks just as easily.

The egg of the ant is plain, smooth and lustrous, without any division. After the larva has made its exit from it, it is no longer anything but a very thin membrane which has curled up and become reduced to an imperceptible point, and even before the egg is hatched it is still so small as to escape the eyes. This is what makes these eggs so little known, for what is commonly and very improperly called the egg of the ant is the latter's larva endowed with life and motion. These eggs, or rather these larvæ, are much in demand as food for poultry.

The eggs of ants are considered a choice dish in some countries. They are spread upon a slice of bread and butter, and sauces are made of them that are considered excellent. In Siam they form a much esteemed and very costly food, solely within the reach of people in easy circumstances. They are the object of an important trade in some countries of the north of Europe, principally in Denmark, Norway and Sweden. In these countries they are cooked in boiling water, and there is thus obtained a sort of vinegar or formic acid.

In Mexico, the eggs of certain aquatic hemipters are eaten. These insects (*Corixa femorale, C. mannaria* and *Notonecta Americana*) habitually deposit their eggs among the reeds and sedges of the lakes, principally of Lake Tescuco. These reeds and sedges are gathered and dried and beaten over cloths in order to detach the myriads of eggs that are attached to them. These eggs are cleaned with the greatest care, and are afterward sifted and put into bags like flour and sold for making bread.

This new kind of food, called *hantlé*, and which, upon the whole, is merely bread made from an aquatic bug, is the object of important transactions in the Mexican markets. The aborigines, before the conquest, made use of this bread, which has a pronounced taste of fish. The eggs of another species, *Corixa esculenta*, which resemble manna, are eaten in Egypt, and form the elements of very choice dishes.

Let us add, in conclusion, that the eggs of insects withstand great variations of temperature. The most intense cold of our winters is incapable of destroying the eggs of the most delicate species, and just so they resist a tropical heat that would suffice to roast meat. —*La Nature.*

THE ORIGIN OF GOLD.

By Philip Lake, Cambridge, England.

The subject of the origin of gold, or of the manner in which that metal has reached its present positions, is one which has at all times excited considerable attention, and the number of theories put forward has been almost as great as the number of writers on the question.

It is easy to understand the presence of gold in alluvial deposits, for this has clearly been derived from pre-existing rocks; but the difficulty lies in determin-

ing how the auriferous quartz reefs and other rocks which we look upon as the home of the gold became impregnated.

Sir Roderick Murchison, from his observations in the Ural Mountains, originally held that non-alluvial gold was only found in Paleozoic rocks, and principally in his Lower Silurian; but he believed it was not introduced into these rocks until shortly before the Drift period. Subsequently he was led to modify these views to a certain extent, and to admit that secondary and tertiary strata, when penetrated by igneous rocks or impregnated by mineral veins, might also contain gold.

More recent observations show that gold may be found in rocks of any age in metamorphic strata; but all the evidence seems to support Murchison's next contention, viz., that gold is of igneous origin.

There is probably no more instructive area to illustrate this than Southern India, where the distribution of gold has been carefully worked out by Mr. R. B. Foote, of the Geological Survey of India. Almost the whole of this part of India is made of crystalline and metamorphic rocks; and in it there are a large number of gold fields, more or less rich. A closer examination of the country shows that we have here a large mass of gneissic and granitoid rock which is crossed by a number of bands of schist, lava flows, hematite beds and conglomerates. Mr. Foote has shown that these bands belong to a system which is distinct from and newer than the gneiss, and to this system he has given the name of Dharwar. He has shown also that all the gold fields of Southern India, with the possible exception of the Wynaad, lie within these Dharwar bands.

As usual, the gold is found principally in quartz reefs; and it is a remarkable fact that though quartz reefs are by no means uncommon in the gneiss, as well as in the Dharwar beds, yet those in the gneiss are never auriferous. It is clear, therefore, that the gold cannot have been introduced into the reefs from below, for in that case there would be no difference in that respect between the reefs in the gneiss and the reefs in the Dharwar.

Only one other possible conclusion remains, viz., that the gold originally lay in the Dharwar rocks themselves, and that it has since, by some process of segregation, been gathered together in the quartz reefs.

It has already been stated that lava flows occur among the Dharwar rocks; and my own observations have led me to believe that many of the schists also are lava flows. In fact a very large part, if not the greater part, of the system appears to be of volcanic origin.

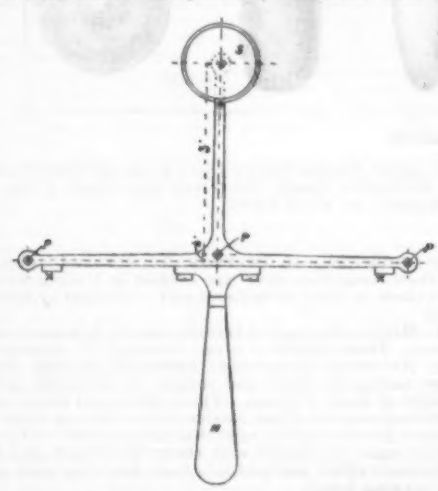
It may be concluded, therefore, that the gold which we now find in the auriferous reefs of Southern India was derived from the rocks of the Dharwar system; and that it was originally brought up from the depths of the earth by the lava flows which form so large a part of that system.—*Science.*

A SENSITIVE SPHEROMETER.

By A. A. COMMON.

THE ordinary spherometer has three arms carrying three fixed points, with a point moved by a screw in the center. This form is an improvement on the original spherometer invented by Andrew Ross, and for which the Society of Arts gave him a silver medal in 1841.

A description of Ross' instrument is given by Holtzapfel, vol. iii., p. 1271, of his work on "Turning and Mechanical Manipulation," extracted from vol.



liii. of the Transactions of the Society of Arts. This instrument could measure to $\frac{1}{1000}$ of an inch, and by estimation half this amount. An ordinary spherometer, with a screw of $\frac{1}{100}$ of an inch pitch and head divided to hundredths, will measure to $\frac{1}{10000}$ of an inch.

I pointed out in vol. l., page 145, of the Memoirs of the Royal Astronomical Society that the sensitiveness of the ordinary spherometer was much increased by placing the screw, not in the center, but in one of the arms in the place of one of the fixed points; this at once increased the sensitiveness of the screw in proportion to the distance of the screw from the nearest fixed point, and this fixed point from a line joining the other two fixed points.

The improvement I wish to bring before those interested in spherometers by this note is the extension of this principle, for by carrying the middle point much nearer the line joining the other two, a proportionate increase of sensitiveness is obtained.

In the case of an instrument I have made on this plan I have increased the sensitiveness thirty times, the distance from the middle point to the screw being three inches, and the distance of the point from the line of the other two being $\frac{1}{10}$ of an inch; with a screw of one hundred threads to the inch and a head divided to hundredths the ordinary form of instrument will read to $\frac{1}{10000}$, but on the plan I give the same screw will measure $\frac{1}{300000}$ of an inch.

There is an aditional advantage in this form, that the curvature of a part nearly in a line is measured, so that cross measures can be taken.

The form of the instrument is not symmetrical, and it requires to be balanced, so that when the screw is raised it will be possible to estimate the frictional contact of the outside points when the middle one is taking the weight. This balancing is easily done by adding a handle to the part opposite the arm carrying the screw; in practice it is found that this handle is of the greatest value in keeping the heat of the hand from the instrument, as even with the ordinary instrument, holding it for a short time in the hand alters the readings materially.

It is of great advantage to have on the arms carrying the two outer pins two pieces of wood or ivory projecting not quite as much as the measuring points, so that by tilting the instrument up these two pieces come first into contact with the surface to be measured, then by gradually raising the handle the points are brought gently into contact. The figure is a plan of this spherometer and shows the position of the three fixed points, P P P, with reference to the measuring screw, S, and the position of the balancing handle, H, with reference to the unsymmetrical arm carrying the measuring screw; X X are the projecting pieces already mentioned.

The movement of the screw being so large for a slight curvature, this instrument is more particularly useful for measuring the slight curvatures of so-called plane mirrors, for which indeed it was designed. To make it available for measuring differences between parts of a curved surface of considerable curvature, the middle pin should be a screw capable of movement to and clamping in a position that will allow the measuring screw to work.—*Nature.*

A MICROSCOPICAL AND ANALYTICAL STUDY OF COCA LEAVES.*

By ALFRED R. L. DOHME, A.B., Ph.D.

Historical.—This cultivated, delicate, but rather ornamental South American perennial has been known and its tonic and invigorating properties made use of since the year 1499, although we learn from the graves and inscriptions of the tombs of the Incas of Peru that the plant had been used as a food stuff and article of luxury much earlier. It was dedicated by the old Peruvians to the sun, and was also used considerably at the time as an article of exchange, taking the place of money. The natives were accustomed to chew it much as tobacco is chewed by the people of this country. This was carried to such an excess that the Vice-King Don Francisco Toledo in 1570 had laws passed prohibiting its use. This was considered rather a harsh measure, as its use enabled the persons chewing it to undergo continuous hardships and perform hard labor without the desire for or necessity of partaking of any food—quite a saving for an economically inclined man, besides the pleasant sensations described as accompanying its use. When the natives intend using the leaves for chewing they prepare them in an especial way, and somewhat as the Chinese prepare their opium preliminary to smoking it. In some parts of Peru the leaves are dried, mixed with ashes, lime and powdered calcium carbonate, and then moulded into small sticks resembling a small stump of a lead pencil.

Descriptive.—*Erythroxylon coca, Lamarck,* is a bush growing to the height of about six feet, and well filled with leaves and blossoms. It flourishes and thrives best on the damp slopes of mountains about 2,000–5,000 feet above the sea level, in a mild warm climate at about 16° 2' to 16° 20' latitude, south. The province La Paz on the slopes of the Andes in Bolivia produces about the largest crops of any in South America. The plant seldom if ever is found growing wild, and is cultivated to such an extent that the annual crop now reaches the enormous figures of about eighty to one hundred million pounds. Most of it is shipped from the ports of Arica, Callao, Mollendo and Trujillo, although a large percentage remains at home for home consumption. The plant is grown from seed and needs no especial care. After the third year it can be stripped of its leaves, in part at least, thrice annually. The leaves are easily dried, being comparatively poor in juice, and pressed into packages called "cestos," weighing about thirty pounds, by means of banana leaves and coarse linen, and three of such "cestos" are then tied together to form a "tambor," this being as much as one pack horse can carry. The culture of coca leaves has been tried in other countries, but with questionable results, except, perhaps, on the island of Java, where it seems the plant finds surroundings suitable to its mode of life and habits, so that a considerable quantity of coca leaves is shipped to Amsterdam from Batavia. Thence they make their way to the southern part of the Rhine countries of Germany, there to be made to yield to the manipulations of the German chemist the beautiful crystalline alkaloid cocaine.

While a student in the University of Strassburg, Professor Fluckiger one day brought to the writer's notice a phamphlet which had just arrived from the island of Java. It was written by a local Dutch chemist, of the name of Dr. Burck, at Tysmania near Batavia, and was entitled "Opmerding over de onder den Naam van Erythroxylon Coca in Ned. Indie gecultivierde Gewassen." It contained some investigations upon the microscopic structure of these leaves, distinguishing two varieties and connecting these with the yield of cocaine obtained by assay. It was read with much interest by the professor, and at the instigation of the latter, the writer undertook an investigation of the coca leaves of the laboratory collection. Unfortunately, only one variety was found and no comparisons could be made. The matter was dropped there, although the writer made some sketches of the drawings of the leaf, stem and the flowers of both varieties given by Dr. Burck in his article. He called the two varieties raised in Java respectively *Erythroxylon Bolivianum* and *Erythroxylon Spruceanum.* As far as he could discover, the writer has not found any notice of Dr. Burck's article in any of our leading pharmaceutical journals. While passing through the establishment of Messrs. C. F. Boehringer & Soehne at Waldhof, near Mannheim, the writer asked Dr. Engelhorn, the head of the firm, if he had heard of Dr. Burck's work, to which he replied that he had not, but would like to procure a copy if possible, as it would probably be of some use to him. Having recently had occasion to assay a number of samples of coca leaves, the writer decided to investigate the matter microscopically and analytically, and see if some interesting data could not be obtained. As is well known, there are two varieties of coca leaves that come into this country—named after two cities of Peru where they in all probability are either grown or whence they are shipped. The varieties are "Truxillo" and "Huanuco" coca leaves, varieties that are distinguished usually by their difference in appearance. The "Huanuco" leaves are usually of a dark green color and a thick leathery consistency, while the "Truxillo" leaves are of a light green color and a fragile brittle thin consistency. The "Huanuco" leaves derive their name from the city of Huanuco, lying between the Maranon and Hualloga rivers on the slopes of the Andes mountains, in the central part of Peru, while the "Truxillo" (properly Trujillo) leaves are named after the port of Trujillo in the northern part of Peru. While this commercial, *i. e.,* macroscopic, mode of distinguishing the leaves is not absolutely correct, it answers the purpose in most cases. The "Huanuco" leaves correspond to Dr. Burck's *Erythroxylon Bolivianum* and the "Truxillo" leaves to his *Erythroxylon Spruceanum.*

Assay.—Samples of both varieties of leaves were ground to a No. 30 powder and subjected to assay by the following method:

Ten grammes of the powdered leaves were placed in a 200 c. c. Florence flask and macerated for twenty-four hours, shaking at regular intervals, with a mixture consisting of 70 c. c. of benzine, 25 c. c. of ether and 5 c. c. of a mixture of concentrated ammonia 1 part, absolute alcohol 9 parts (100 c. c. in all). After standing thus for twenty-four hours 50 c. c. were filtered off and shaken in globular* separators, with successive portions of 10 c. c. of water and 2 c. c. of a 5 per cent. solution of sulphuric acid, until a drop of the latter gave no cloudiness upon treatment with a solution of mercurio-potassium iodide. The acid solutions were combined in one separator and treated with about 15 c. c. of a benzine-ether mixture to remove all the coloring matter, etc., taken up by the acid water. They were then made alkaline with ammonia and treated with two successive portions of 20 c. c. of ether, the latter being drawn off into a tared beaker. In order to remove the ether (and with it the cocaine) that had been dissolved by the water, the latter was treated with 20 c. c. of chloroform, which readily removes the last traces of cocaine from the alkaline liquid.

The chloroform was then drawn off into the tared beaker containing the ether extracts and all evaporated, and finally heated to constant weight at 100° C. and weighed. This gave the gravimetric result. The residues were then dissolved in decinormal hydrochloric acid by the aid of gentle heat, and the excess of the acid titrated with centinormal alkali, using a decoction of Brazil wood as an indicator. This gave the volumetric result. As has been clearly demonstrated in another paper presented to this association,† the only known reliable method of assaying at present is just this last mentioned method of titration by means of volumetric acid solution. The results follow:

	Sample A.	Sample B.	Sample C.
Huanuco leaves‡ (Erythrox. Bolivianum)	Gravimetric, 0·87 per cent. Volumetric, 0·61 per cent.	Gravimetric, 1·75 per cent. Volumetric, 0·29 per cent.	Gravimetric, 0·746 per cent. Volumetric, 0·56 per cent.
Truxillo leaves‡ (Erythrox. Spruceanum)	Gravimetric, 0·79 per cent. Volumetric, 0·18 per cent.	Gravimetric, 0·606 per cent. Volumetric, 0·065 per cent.	Gravimetric, 5·575 per cent. Volumetric, 0·068 per cent.

From these results we see that Huanuco leaves are better than Truxillo leaves as far as their yield of cocaine is concerned; for although the gravimetric results do not show such a great difference, the volumetric results do. This is proof positive that by the method used, being about the best method known to the writer, the gravimetric results for coca leaves are almost absolutely unreliable.

Microscopical Examination.—If several good sized, sound and well cured Huanuco and Truxillo leaves are soaked in water for several hours and thin cross sections of them, cut so as to include the midrib, made by means of a sharp flat ground razor or a microtome, we are in a position to examine them under the microscope and see if we have a ready means of distinguishing the Truxillo from the Huanuco leaves microscopically. As has already been pointed out,§ it is essential to have the sections cut very thin, in fact so thin that they appear transparent, even to the naked eye.

The distinctive differences to be noted are the apex of the midrib in the case of the Huanuco leaves and its absence in the case of the Truxillo leaves; furthermore, the spread-out and almost flat position of the woody fibers and ducts in the case of the Huanuco

* A paper read before the American Pharmaceutical Association, August, 1893.—*Pharm. Era.*

* The experience of the writer has been that a globular separator, drawn to a tube about an inch long between the globe and the stop-cock, will enable the operator to shake the inclosed liquids more readily and advantageously, and with less chance of forming an emulsion, than any other separator he has used.

† Caspari and Dohme—"The Value of Titration with Volumetric Acid Solution as a Means of Assaying Alkaloidal Drugs and Galenical Preparations."

‡ These leaves were obtained from different parties to insure their being from different lots, each party sending samples of both kinds.

§ Dohme—"The Practical Use of the Microscope in Pharmacy"—Proceedings Amer. Pharm. Assoc., 1892, page 344.

leaves and their more circular and condensed position in the case of the Truxillo leaves. Otherwise there is little difference to be noted. The leaves hence that show the apex and have their woody fibers and ducts spread out rather flat across the section are those that yield the most cocaine, and are hence the most valuable.

CANADIAN POTASH.*

By T. D. REED, M.D., Professor of Materia Medica, Montreal College of Pharmacy.

THE manufacture of "Pots" and "Pearls" in Canada has greatly fallen off in recent years. The competition of the mineral or German chloride has much debased the price, thus rendering the manufacture from wood ashes little profitable. The consumption of unleached ashes for agricultural purposes has also had its effect.

Potash is still, however, an important article of export, as is illustrated by the fact that nearly two millions of pounds weight of "Pots" and "Pearls" (1,800,000 lb.) passed under observation in the government inspection office at Montreal in 1891, and a million and a half (1,409,200) in 1892. The records of the inspection office extend over half a century, and during that time the year of greatest output was 1850, when twenty-seven millions of pounds were exported.

It is stated in Roscoe & Schorlemmer that at the time of the Vienna Exposition the record of the world's production of potash alkali from wood ashes for 1870 was 20,000,000 kilos. If these figures are correct, Canadian potash accounted for one-fourth—10,000,000 pounds.

The writer paid a visit recently to one of the oldest factories in the province, situated in St. Sauveur, a suburb of Quebec. Here potash has been made for over thirty years. A light wood building is divided into two compartments; in one the year's stock of wood ashes, collected in the winter, is stored; the other contains the percolators and furnace. The percolators are wooden cylindrical vessels, like immense hogsheads. The furnace is built of stone, and contains embedded in it three potash "kettles." These are hemispherical pots of cast iron, thirty-seven inches in diameter. They are arranged in line from the front to the back, so as to utilize the heat before its disappearance up the chimney. Nos. 1 and 2 are used for evaporating and melting and No. 3 for heating water for the percolators.

The process for exhausting the ashes is a repercolation; the lye from the first vat is poured into the second, and so on until strong. The liquid poured on top passes through the ashes and then through a layer of slaked lime, on a shelf near the bottom. The fuel was very dry, soft wood, making a fierce blaze.

Two kettles of fused potash were made in four days without working at night. The complete evaporation of the water is manifested by the appearance of the seething contents of the kettle changing to that of a quiet, oily liquid, which soon becomes red hot. This is now ladled into iron moulds to form cakes of about 325 lb. Two cakes make the contents of a cask. The casks are of hard wood, generally oak, the legal size being 32 × 22 inches. Two pounds of dry lime per cask is allowed as a preservative dusting powder.

In a good sample, on breaking the cake, a gray appearance, slightly pink, is seen with a heart of different colors, as white, pink, blue, etc.

For inspection, from a fresh fracture, a portion is broken off and one hundred grains dissolved to be titrated with standard acid for its proportion of alkali estimated as KHO. As there is always some carbonic acid gas evolved, methyl-orange becomes desirable as an indicator. Seventy per cent. and upward, if free from the suspicion of salt, leads to the brand of "first sorts."

During the last two years the range has been from 36 per cent. to 84 per cent. Prof. Lloyd, in an important paper presented to this association at its last annual gathering, reported a sample of American potash testing 91·28 per cent. This is astonishing, as it is stronger than the limit of the U. S. P. or B. P. for fine white stick potash, and much better than the samples reported on by Messrs. Goebel & Patch in 1885. The writer has not met with any stronger than 84 per cent. In addition to real potash, chlorine is especially estimated, as the presence of salt is injurious in soft soap manufacture and other processes. The chlorine is readily found by means of a volumetric solution of silver nitrate with potassium chromate to indicate the completion of its precipitation.

In the products of one manufacturer, whose works were inspected, and in whose *bona fide* confidence was placed, 6 per cent. has been found. As much as 20 per cent. has been met with. In this case adulteration may well be assumed. The workmen handling the potash acquire wonderful skill, by observation alone, and pronounce on the quality with general accuracy without any knowledge of chemistry.

Caustic soda being a possible adulterant, some samples were submitted to Professor Ruttan, of the chemical department of McGill College, for thorough analysis; they were in every case pronounced free from added sodium. The following are some analyses made at McGill of very good and very poor Canadian potashes:

K O H	70·210	53·24	63·06
K_2CO_3	9·194	7·66	22·55
Na Cl	1·46	12·90	1·02
K_2SO_4	2·31	11·41	3·73
Insoluble	1·385	1·22	3·899

In the manufacture of pearlash, the lye without lime is evaporated to a condition of black salts, then burnt on the hearth, redissolved, siphoned off bright, evaporated and again burnt, a beautiful granular product with a bluish tint being obtained. This manufacture is in very few hands in Canada; 165,000 lb. passed through the Montreal office in 1892. It was almost uniformly of excellent quality, averaging over 90 per cent. pure.

The difficulty of obtaining good potash and pearlash in the United States, suggested by the tone of Prof. Lloyd's paper, would be met by applying to Montreal, if the customs rate be not a bar financially. The purchaser of "Pots" and "Pearls" with the Canadian brand "First Sorts," may rely on a good article; the inspection is real, every lot being subjected to chemical tests under the direction of a sworn government officer.

The leached ashes are found to be very valuable in agriculture, probably on account of the unextracted phosphate, and the sale of this helps in a way to make commercially possible the manufacture of potash at the low prices now ruling.

With cheap potash it would seem that a combination with Carolina fossil phosphates could be made which would be very precious for agricultural purposes, returning to Mother Earth some of the most valuable elements of crop stimulation.

The market quotations in Montreal at present would be First Pots, about 4¼c.; First Pearls, about 5¼c.

For permission to use the figures and facts on which this paper is based I am indebted to the kindness of E. J. Major, Esq., Ashes Inspector at Montreal.

91 University Street, Montreal, August 10, 1893.

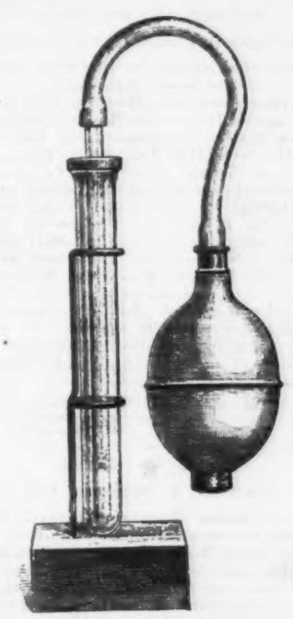
In a discussion that followed the reading of the paper, Prof. Lloyd (Cincinnati) stated that, owing to the decrease in the manufacture and quality of American potash, the users of this material were looking to Canada as the source of their future supply. The Canadian article, he added, was of a high standard, and was remarkably free from adulterants.

* Paper presented at the forty-first annual meeting of American Pharmaceutical Association, held in Art Gallery, Chicago, August 15, 1893, and read by J. E. Morrison, Montreal, in absence of the author.

A NEW CARBONOMETER.

By W. MOLESWORTH, M.D., Brooklyn, N. Y.

I WISH to invite the attention of the profession briefly to my new carbonometer, believing it to be the only convenient, cheap, and portable device of easy application, for determining the excess of carbonic acid in the atmosphere, in school rooms, sick rooms, hospitals, mines, tenement houses, etc., where absolute accuracy is not required. While the thermometer shows the temperature of a room, the barometer the density of the air, and the hygrometer its moisture, we have had no simple device for testing its pollution as the result



of combustion or respiration. When the actual health of the occupants of any given apartment is taken into consideration, there is no one thing of more importance than the quality of the air itself; and, recognizing the fact that there is no better test of its pollution than the per cent. of carbonic acid which it contains, by aid of the carbonometer you can approximate the quantity near enough for ordinary use, and it should be found in every school room or other apartment subject to vitiation of its air.

Each apparatus consists of a glass test tube about five and a half inches long and nine-sixteenths of an inch in diameter, together with a smaller tube about six inches long, contracted about one inch from either end, with a valvular rubber bulb and tube to attach; also a rubber ring to fix its depth in the test tube, a wooden and wire stand for supporting it, with a small bottle each of lime water and vinegar, and a little brush for cleaning the test tube.

Fill the test tube for about one inch, up to the horizontal line, with a perfectly clear saturated solution of lime water; take the smaller tube with bulb attached, adjust the rubber ring so that it will hold the tube about three-eighths of an inch from the bottom of the test tube; gently compress the rubber bulb till all the air is expelled and then allow it to fill again with moderate rapidity, and so continue as often as desired. If, after filling and discharging the bulb six or eight times, the opacity of the lime water obscures the black spot on the base of the stand, the air is absolutely unfit to inhale; and if, after filling the bulb fifteen to twenty times, the black spot is obscured, the observer looking downward from the top of the test tube through the lime water, the air is unfit for continuous respiration. In good air the spot ought not to be obscured in thirty or forty fillings of the bulb, and in pure air not at all. This instrument should be used in daylight, and the test tube washed out with the brush or otherwise after each observation; if incrustations of carbonate of lime form on the tube, remove with a little vinegar, after which wash thoroughly with pure water and wipe dry.

To obtain an idea of its workings, fill and discharge the bulb eight or ten times with the exhalation from your own lungs, and observe its action on the lime water.—*Medical Record.*

THE PRODUCTION OF OXYGEN FROM THE AIR.

THE separation of oxygen from the nitrogen of the air has been practically effected by two processes, both of which depend upon (1) the formation of higher oxides of certain metals and (2) the elimination of the oxygen from the higher oxides by the application of high temperatures or of superheated steam. It is well known, for example, that most of the oxygen used in London for limelight purposes, including, we should add, inhalation experiments, is produced directly from the air by means of Brin's expedient, which consists in exposing ordinary heated baryta (BaO) to air that has been freed from carbonic acid. The peroxide of barium (BaO_2) which is thus formed readily yields oxygen on the application of a higher temperature, the reduced oxide (BaO), which may be used again and again, remaining in the retort. Another method of obtaining oxygen from the air consists in heating manganate of potassium ($KMnO_4$) in a current of steam, when oxygen is evolved and caustic potash and the lower oxides of manganese are formed. The caustic potash and the reduced manganese are treated again in contact with air, when manganate due to absorption of the oxygen of the air is reformed. So this process, like the last, is practically continuous. More recently a process which appears to offer certain advantages over others in vogue, though its action is more complex, has been studied, with the view of establishing it on a commercial scale, by G. Kassner, a German chemist. This chemist employs, in the form of spongy porous masses, calcium plumbate (Ca_2PbO_4), a compound of lime with peroxide of lead, which being first exposed to moist furnace gases absorbs carbonic acid and is converted into a mixture of carbonate of lime and free peroxide of lead. Then, on heating this mixture in a retort, oxygen, at first in a state of purity, is evolved, but as the temperature rises it is contaminated, more or less, by carbonic acid, which is readily removed, however, by passing the gas over a column of the fresh plumbate. Toward the end of the operation, which is assisted by means of a current of superheated steam, carbonic acid gas in a state of purity is given off. The residue in the retort, consisting of an intimate mixture of lime and litharge (PbO), is reconverted into plumbate by simply driving a current of air through the heated mixture in the retort. Thus the plumbate can be used over and over again in the same way that baryta or manganate is used in the processes previously described. The purity of oxygen is a matter of considerable moment, of course, when the gas is intended for purposes of inhalation. In industrial and other applications, too, it is necessary to employ fairly pure oxygen if good results are desired. Judging from recent literature on the subject of oxygen in its application in the arts and industries, there appears to be an increasing demand for a process which will provide a pure gas at a reasonably cheap rate. Of the individual processes described, however, experience must be left to decide which is best suited for the purposes in view. Already oxygen has been suggested as an effective agent in the purification of sewage, but as yet no practical success seems to have attended the efforts of the enterprising investigators.—*The Lancet.*

SODIUM.

SODIUM resembles potassium in several respects, but it is lighter and harder, and the lustrous silvery white surface it presents when newly cut assumes a pinkish tinge before acquiring a gray hue. Potassium turns to a bluish-gray. Sodium is compressible between the fingers, like wax, but it ought to be handled under the surface of kerosene oil, as it takes fire easily in combination with moisture, even with perspiration, and the attendant burns are of the worst kind. It can be easily divided with a meat chopping knife. It retains its plasticity at the freezing point of water, which potassium does not.

Sodium is so light a metal that it requires about 28 cubic inches to make one pound; so that if cast, as is usual, into ingots about three-quarters of an inch square and six inches long, at least eight of these would be required to make a pound. These ingots are usually packed in oil in glass-stoppered bottles or sealed metallic cylinders. Its specific gravity at its boiling point (900° F.) is 0·744, at its melting point (200°) 0·929, and at 32° from 0·9348 to 0·9766. Its expansion with heat is great, therefore, for a metal—about four times that of quicksilver—and it ought to be useful for thermometers to register temperatures above 600°, where mercury becomes unreliable. As a conductor of heat and electricity sodium is surpassed only by gold, silver, and copper.

The vapor of sodium has a purplish tint. When masses of sodium are thrust under the surface of water the explosions that follow are nearly, if not quite, equal in violence to those of potassium, but when placed on the surface of water it decomposes that liquid with violence. Still, unless the water is hot, it does not take fire. If, however, a small quantity of water is brought in contact with it on a surface which is not a good conductor of heat, as a piece of wood or charcoal, for example, it takes fire and burns with great energy. It needs to be handled with great caution.

Sodium is found in nature chiefly in the form of common salt, its chloride. It is exceedingly abundant, and though it now sells for 50 or 75 cents a pound, it could be produced much more cheaply if there were any use found for it. Davy discovered it in 1807 by electrolysis of caustic soda with a powerful voltaic battery. Carbon also decomposes that salt at high temperature and is now practically the only agent used in obtaining sodium. Gay-Lussac and Thenard found that iron would also perform this work, and Castner, an American inventor, devised a method of using iron and carbon together, but this is not likely to supersede carbon alone.

Sodium and potassium when alloyed together present the extraordinary phenomenon of a permanently liquid metal, like quicksilver. This is in accordance with a law which is very general—namely, that alloys melt at lower temperatures than the mean melting point of their component metals. This law is of high practical importance. It has a general application to other metallic alloys (the "fusible alloys" being exam-

ples), as well as to mixtures of salts, hydrocarbons and most other classes of compounds.

We have here an extreme case, in which two metals, one melting at 144° F. and the other at 200°, form alloys melting below the ice temperature, if the proportions are about eight pounds of potassium and five pounds of sodium. These alloys are obtained by placing clean pieces of the two metals together under heavy hydrocarbon oil and applying a gentle heat. Even without heat the writer has found them to alloy spontaneously on standing. By the action of sodium on fused acetate of potassium, it is said, another liquid alloy results.

If the suggestion already made of a thermometer for temperatures nearly if not quite up to incandescence should be found feasible, the use of this liquid alloy would extend the scale downward to the melting point of ice or lower. Moreover, it would not be necessary, as with solid sodium, to immerse the tube as well as the bulb. The degrees of such a thermometer would be four times as long as in mercurial thermometers. They would have to be very carefully protected from fracture, and several precautions in both manufacture and use would have to be observed, for which we have not space.

There are other applications of these liquid alloys which should now be experimented on by inventors, since it has now been proved that both alkali metals can be made reasonably cheap if a demand is created. Twenty-five years ago the writer tried to call attention to sodium as an agent for blasting. A cartridge for that purpose was suggested on a very simple principle. The sodium was to be melted into the lower end of an iron cylinder fitting the borehole and open at the upper end. A thin layer of some fusible, soluble, saline substance was to be melted in over the sodium.

The borehole could then be filled with water from a distance through a hose. An explosion must follow, of course, as soon as the protecting saline coating was dissolved and the sodium exposed. It is doubtful whether this plan was ever realized in practice. Sodium would be safer than the dynamite of the present day, being wholly free from any possibility of spontaneous explosion, even by application of heat. Only immersion under water can cause explosion. The use of the liquid alloys here would certainly be best, and the writer sees some practical difficulties which would disappear with their use.

A method of electric blasting in this way has also occurred to him. In this case the coating over the sodium or liquid alloy would be a layer of a paraffine composition, with a coil of fine iron wire embedded in it. When the electric current was passed through this coil the paraffine would melt and let in the water from above. It must be added that this mode of blasting is adapted only to the open air, and not to mines, on account of the caustic alkaline smoke produced.

If the doctrine be sound that wars will cease when agents are introduced against which there is no defense, then the use of these alkali metals, and especially of their alloys, in warfare would be justified. Shells filled with the latter in liquid form bursting on or in a vessel, or in a fortification, would render it untenable by human beings. The inhalation of the caustic smoke would be as fatal as the breathing of fire, and the eyes could not be kept open in such smoke.—*N. Y. Tribune.*

A NEW METHOD FOR DETERMINING THE FATTY MATTER OF MILK.

By LEO LIEBERMANN and S. SZEKELY.

FIFTY c. c. milk at the temperature of the room are put in a glass cylinder about 25 cm. in height and about 4½ cm. internal diameter; there are added 5 c. c. of potassa-lye at 1·27 specific gravity, closed with a well-fitting cork, and well shaken.

To this mixture are added 50 c. c. of a light petroleum ether, the specific gravity of which is about 0·663, the boiling-point 60°, and which evaporates on the water bath without residue. The glass is stoppered and again vigorously shaken so as to form an emulsion. To this emulsion are added 50 c. c. alcohol of about 95·8 to 96 per cent., and the liquid is again well shaken. After at most four or five minutes the petroleum ether separates at the top, and the separation may be regarded as complete. We shake again three or four times, each time for a quarter of a minute, allowing each time the ether to separate out.

The petroleum ether will now have taken up all the fat. We ascertain this point by shaking up eleven specimens a different number of times, the first once and the eleventh eleven times. Already after the third or fourth shaking we have found quantities of fat which differ from each other only to an unimportant degree—after once shaking 3·535 per cent., after twice shaking 3·54 per cent.; and the results which we obtained between the third and eleventh shaking fluctuated only between 3·55 and 3·56 per cent.

Of the stratum of petroleum ether, 20 c. c. are drawn off with a pipette and introduced into a small tared capsule, the capacity of which is about 40 to 50 c. c., and the neck of which is higher than 1 cm., with a diameter of 1½ to 2 cm. These small flasks are convenient, because the liquid does not readily rise out of them, and yet the evaporation goes on with sufficient rapidity; but of course small tared beakers or ordinary flasks may be used.

The flask is set upon a water bath at a moderate heat, the petroleum ether is evaporated entirely away, and the residue is dried at from 110° to 120°, for which an hour is generally sufficient; the weight found, if multiplied by 5, gives the quantity of fat in 100 c. c.

The quantities of fat obtained by the new method may be easily recalculated by the aid of the specific gravity into percentages by weight, so as to admit of a comparison with the Adams method, in which the milk is weighed. We remark that on the Adams method the extraction with petroleum ether must last for at least three hours.

The results of the new method vary from those of the gravimetric method by 0·066 in a positive direction, and by 0·037 per cent. in a negative direction. But these deviations, in our opinion, are not necessarily founded on the sources of error in the method, but are chiefly due to the circumstance that in the gravimetric method the milk is weighed, while in the new method it is measured, and that the recalculation may occasion errors.—*Zeitschrift f. Anal. Chemie*, xxxv., p. 168, from *Chem. News*, 1893, 281.

PREPARING RED PIGMENTS.

WITH a view to obtaining a red pigment composed of ferric oxide the following process has been patented, the method being specially intended for the treatment of blue billy. This compound is heated in a retort with ammonium sulphate. Ammonia is driven off and sulphate of iron formed, the latter being decomposed by raising the temperature to a low red heat, when Nordhausen sulphuric acid is given off and ferric oxide left in the retort. A small amount of lead nitrate or iron nitrate may with advantage be added to the first charge of blue billy and ammonium sulphate, the gases given off being led into a second retort containing blue billy, air and steam.

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